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THE RACES OF RUSSIA

(WITH 1 MAP)

BY
ALEŠ HRDLIČKA

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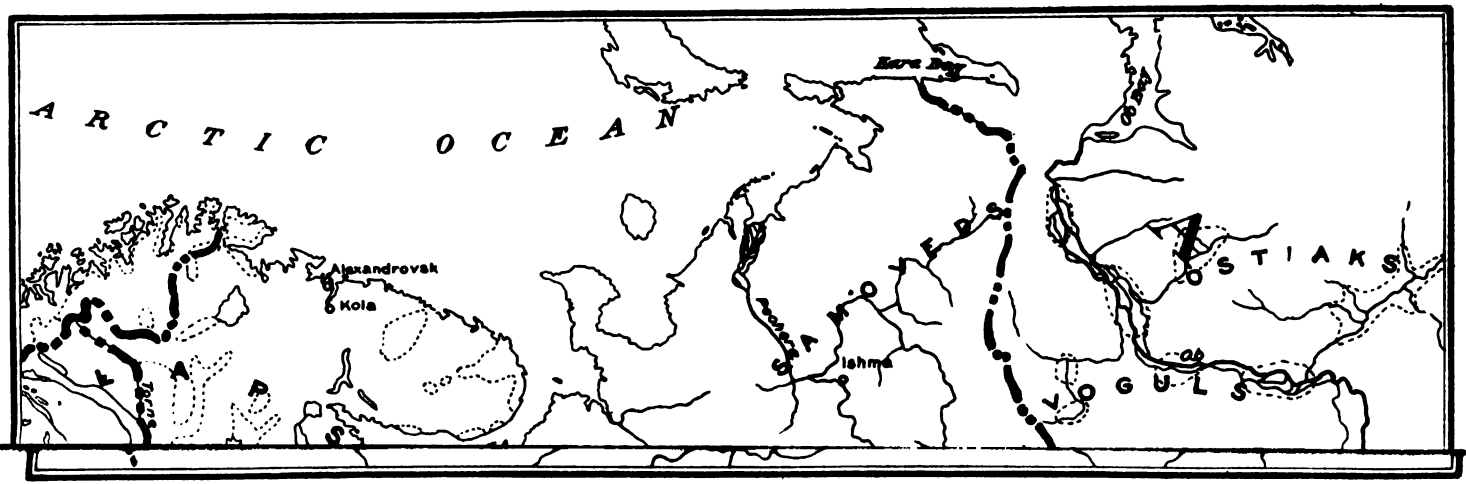

HISTORIC MOVEMENTS OF POPULATIONS IN EUROPEAN RUSSIA.

———— Spread of the Slavs.
— — — — Invasions by Asiatics.
- - - - - - Invasions by Nordic tribes.

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THE RACES OF RUSSIA

By DR. ALEŠ HRDLIČKA,

CURATOR, DIVISION OF PHYSICAL ANTHROPOLOGY, U. S. NATIONAL MUSEUM

The subject of the races of Russia—the great Russia that was yesterday and that must be again if the world is to know any peace—seems very baffling, and is in fact far from simple. Yet if the field is viewed from a higher horizon, with due historical and anthropological perspective, many of its irregularities disappear, and where at first there seemed to be an almost hopelessly involved mosaic of ethnic differences there are seen great areas of fairly uniform racial color.

So far as known to science, European Russia began to be peopled during the latter phases of the paleolithic epoch and the following neolithic times. Some skulls found in Russian Poland and southwestern Russia show features that still remind the anthropologist quite strongly of those of the Neanderthal man, but on the whole the type is already fairly modern. The remains from these earlier times are, however, still rare and limited to territories into which extension from the more southern and western parts of Europe was easily practicable.

A much more important peopling of European Russia took place during the latest neolithic, and the bronze and iron periods; and it proceeded, as far as is now discernible, not only from the adjacent regions in Europe, but also over Caucasus and from the great steppes of Asia. The western Asiatic or Ural-Altaic elements, evidently quite early and numerous, overran and sparsely settled or roamed over perhaps as much as two-thirds of the great region of what is now European Russia, reaching in the north to the limits of the land, in the west as far as Finland, Esthonia, Livonia, and approximately the thirtieth meridian, and in the south below the latitude of Moscow. At about the same time the southeastern and southern parts of Russia became peopled by Turanian and Iranian tribes, spreading over the Caucasus and from beyond the Caspian. Only the western and southwestern parts of the great territory received

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the overflow from the adjoining countries of Europe. The southern grassy plains became then a broad and important avenue for a long series of movements of populations, directed principally from east to west, and the territory was gradually covered with remnants of these populations. This much is known, though the details of these earlier ethnic movements in Russia are lost in the haze of antiquity, or preserved merely in historical fragments.

The first tribes occupying part of the territory which is now Russia, with whose specific name we meet in ancient chronicles, are the Cimmerians, the people whose name is perpetuated in that of Crimea; and the Tauri, from whose name was derived that of "Taurica," the other old name for the Crimean peninsula. Our actual knowledge of these peoples is, however, very limited. Neither reached great importance. The Cimmerians, who probably antedated the Tauri, occupied a part of Crimea and the territory north and northeastward, extending to and about the Palus Maeotis (Sea of Azov); they eventually came into contact with the Thracians and possibly other European groups; but their affinities seem to have been with the Caucasus and the Asiatic countries to the southward, rather than with Europe. They are said to have eventually disappeared into the regions south of Caucasus, being replaced, possibly before 1000 B. C., by the Scythians. The Tauri, probably of the Turanian stock and reputedly very barbarous, occupied the peninsula up to the time of the Greek colonization, after which their name gradually disappears.

This brings us to the more strictly protohistoric times of the region under consideration, the period of the Greek voyages and colonization along the shores of the Euxine (Black Sea). At this time the whole vast territory had already been subdivided among various tribes.

These protohistoric populations first became better known as a result of the famous march into their country of Darius Hystaspes—the first Napoleon—about 512 B. C., and more especially through the writings of Herodotus, about 450 B. C. Of those populations that were mainly of Asiatic origin, by far the most prominent were the "Scythians," whose territory embraced practically the whole present southern Russia below about 50° of latitude. Peoples of related origin covered the country from the Urals to Finland and from the Volga to Esthonia. They were subdivided into numerous tribes and differed somewhat in blood, but all belonged to the Turkish, Tartaric, Finno-Ugrian, and Laplandic subdivisions of the

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great Ural-Altaic stock of Asia. All these peoples, including the Scythians proper, had in common a greater or lesser admixture of Mongolian blood, many were nomadic or semi-nomadic, none being strictly agricultural, and except where in prolonged contact with other peoples, such as in the case of the Scythians with the Greeks, the Bulgars with the Khazars, or the Finns with the Scandinavians, their culture was of a low order.

The more northern and less hospitable regions were only sparsely settled, developed no native political units of importance, and played but a secondary part in the history of European Russia. The more southern of these populations, on the other hand, were much more numerous, showed greater virility, and, possibly under Iranian influence, greater powers of organization. They gave rise to the old Scythia; they constituted for two thousand years the dread southeastern background to the European peoples of Russia; and they were the sources, under one name or another (such as Huns, Avars, Turks, Tartars, etc.), of many disastrous invasions of southern Russia and even central Europe from the third to the thirteenth centuries of our era.

The term "Scythians" deserves a few remarks. Due to their warlike qualities and the direct intercourse with them by the earlier Greeks, few "barbaric" nations of the pre-Christian era have been more mentioned, and few peoples since have given rise to more speculation as to their racial identity. On the basis of our present historical and archeological knowledge it may, however, be safely said that the early Greeks applied the term Scythians not to a race, but to a mass or conglomerate of peoples, partly nomadic and partly agricultural, who occupied the southern part of Russia when the Greeks began to explore and colonize the coasts of the Black Sea.[1] The main strain of the more eastern Scythians was undoubtedly Tartar or Turkish, but probably tinged with Iranian. To the west of the Borysthenes (Dnieper), however, and particularly in present Volhynia, Bukovina, and Galicia, the principal strain and possibly exclusive element of the population from the earliest times was evidently of European extraction, and this stock could have been in the main no other than Slav. To it belonged tribes such as the "Neuri" (Nestor, the earliest Russian historian, mentions "Norici, who are the same with the Slavs"); the Alazones or Halizones (which in Russian would be Galitshani, after which Galicia); and possibly the Borysthenitae husbandmen.

[1] Compare Ellis H. Minns—Scythians and Greeks, 4°, Cambridge (Engl.), 1913.

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The true Scythians claimed to have occupied the country in which they were found by the Greeks for many centuries. As shown by their customs described by the Greeks, and by the remains of their culture uncovered by archeological exploration, they were not wholly a barbaric people; and contrary to what may be observed with later Tartar tribes, their war-like activities were directed mainly toward Persia and Asia Minor rather than toward Europe. It was to avenge their invasion of Medea and Persia that Darius undertook his memorable incursion into their country. Proceeding over Hellespont and the Danube he reached as far as the "Oarus" (supposed to have been the Volga, but more probably the Dnieper), only to find his great effort against the nomads quite futile. He finally barely escaped back across the Danube with the famished remnants of his army.

Scythia, which never formed a highly organized, cohesive political or national unit comparable to that of Persia or Greece, existed, with waning vigor, until the early part of the Christian era, when it gave way before the Gothic, Hun and Khazar invasions; but the name, as applied both to the country and to its inhabitants, persisted for many centuries afterward.

Scythia itself was subject to invasions, which deserve some consideration. Shortly after the commencement of the present era, there are noted in Europe, and between Europe and Asia, movements of peoples which are commonly referred to as "the migrations of races," but which in the main were invasions for conquest or plunder, or were the results of displacements, not seldom forcible, of tribal groups in regions where the density of population had surpassed the resources and the struggle for existence had become acute. They doubtless succeeded older movements of similar nature, of which we have little or no knowledge. They followed two main directions—from the north southward and from the east westward. Russia that was to be, was in a large measure the avenue over which these migrations took place.

The first of these invasions into what is now Russian territory of which we have better knowledge is that of the Goths, though some indications make it possible that these were preceded by less important offshoots from the same stock of people. The Goths were of Scandinavian origin, coming originally perhaps from or over the large island in the Baltic which still bears their name (Gothland). From this they easily traversed the Baltic, known in the early Russian annals as the "sea of the Variags" or Scandinavians, and landed somewhere on what is now the Prussian coast, in the vicinity of the

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Vandals and probably not far from the Vistula River. There they remained for a time; but when the number of people increased greatly, Filimer, their king, "decided that the army of the Goths with their families should move from that region," and "in search of suitable homes and pleasant places they came to the land of Scythia." (Jordanes, Getica, 551 A. D.) Whatever the details of their invasion, it is certain that by the beginning of the third century A. D., the Goths reached as far as the western parts of Scythia, to the Black Sea and the Danube, as well as to the south of the Carpathians. They then became known as the western and the eastern Goths, or Visigoths and Ostrogoths; and the latter, with whom alone we are here concerned, were found at the beginning of the fourth century ruling over the territory from the Carpathians to the Sea of Azov. This rule they kept up until 375 A. D., when their state under Hermanric, together with the remainder of Scythia, was broken up by the invasion of the Huns. Most of the Ostrogoths who survived sought refuge in the southwestern part of Europe; while those who remained were subject to the Huns until after Attila's death, or about 460, when they moved bodily into Pannonia, granted to them by the Romans.

However, the Goth sovereignty in southwestern Russia should not be viewed as an occupancy of a waste or depopulated region by a new race. The territories in question were peopled before, and remained so after the period of Goth domination. And their population was not Goth but in all probability Vendic or Slav, though there are also mentioned the Callipidae (Gepidae), the Alans, and the Heruli, who may have been some of Alpine and some of Nordic extraction. The Goths were warlike northerners, who forcibly invaded Scythia in considerable force for the time, and brought with them their families. Due to their favorable original geographical position and their sea activities they, much like the Germans of to-day, were more advanced in culture and especially in military art and equipment, than the inland populations that so far were relatively only slightly affected by the rest of the world. As a consequence the northmen found little difficulty in overrunning great areas occupied by the sedentary as well as the nomadic primitive tribes, which had little political unity and no adequate power of resistance. Some such tribes could even be employed against others, though of their own blood, and the invader finished by becoming the ruler. We have excellent illustrations of similar processes elsewhere, such as many centuries later on the American continent, in

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Mexico and Peru. But the invaders, though they may create a state under their own banners, are seldom strong enough to give the conquered people their language, and though their name may remain, as has happened later in Bulgaria, the conquerors themselves disappear, either by being driven out or through rapid amalgamation. Thus the Ostrogoths who gave way eventually before the Huns were in all probability merely the usurping and ruling class, together with their military; and when they were driven westward they left little, if anything, behind them that would permanently affect the type of the indigenous populations. Moreover, they doubtless carried with them, in their families, households, and the army, many elements and perhaps even whole groups of these populations.

The great Hun invasion which overcame and finally drove out the Ostrogoths, and which was one of the most sustained and serious of the Asiatic invasions of all times, still further obliterated Scythia and disorganized the whole region of the present Ukraina and Bessarabia. Some of the Scythians possibly remained under other names, while others may have receded to Asia; at all events they vanished as a power and entity. They left thousands of kourgans or burial mounds over southern Russia, but probably also, like the Goths, affected in no great way its future population.

The Hun swarm came from beyond the lower Don and Volga. In blood they were of "Tartar" or Ugrian derivation, and partly—perhaps largely—Mongolic.[1] Their language, like that of all the native population east of the Slav Russia, belonged to the Ural-Altaic. From southern Russia they extended their incursions over most of western Europe, reaching finally as far as northern France, where on the Catalaunian plain they met their Marne. Soon after this defeat, in 455, their dread chief Attila died, the power which they established in Pannonia and Central Europe rapidly crumbled, their confederates, among whom were some of the Germans and even Ostrogoths, broke loose, and what remained of the horde, no longer able to hold its ground, retraced their steps eastward beyond the Dnieper and were lost to sight. Exactly what effect the Hun invasion and prolonged occupation had on the population of southern Russia is difficult to gauge, but it was probably more that of destruc-

[1] It seems almost superfluous to state that racially the Germans have nothing in common with the Huns. The only present European relations of the Huns are the Magyars and Turks, the blood of both of whom, however, is now so much mixed with that of European or Asia Minor populations that the original types are submerged.

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tion and dispersion than blood admixture. Yet remnants of the Huns may have remained in what was once Scythia for a long time after their original name disappeared.

The Scythians, together with the problematical Sauromatae, the Goths, the Huns, and other early groups, became now gradually replaced in southern Russia by a new ethnic unit, the Khazars. The Khazars were, according to many indications, of Caucasus or Asia Minor extraction, and related to the Georgians and Armenians. There were with them, however, also the so-called "Black Khazars," who may have been Huns. Their history in Russia extends over a very considerable period of time—from the end of the second to the eleventh centuries. Between 600 and 950 their territory spread from the Caspian Sea to the Don and later even into Crimea. They were relatively civilized people, who built towns and engaged extensively in sea trade, which earned them the name of the "Phoenicians" or "Venetians" of the Caspian and Black Seas. In the earlier part of the seventh century their power was such that they compelled the agricultural Slavs of the Dnieper and even those of more northern regions to pay tribute. About 740 they accepted Judaism. But during the ninth and tenth centuries they were gradually overwhelmed by the Russians, and in the eleventh century they practically disappeared from the stage. Remnants of the Khazars probably still exist in the Caucasus. What effect this interesting ethnic unit had on the blood of the Russian population it is hard to estimate, but at most it was not extensive.

The Khazar occupation of the regions which now form southeastern Russia was, however, far from uniform and continuously peaceful. The waves of invasion of the Turkish and Tartar tribes from farther east followed one another with greater or shorter intervals and over approximately the same roads, the broad open steppes, traversed before by the Huns. Some of these invasions it is not necessary to enumerate in detail. The more important ones were those of the Bolgars, in 482,[1] of the Avars, in 557, and those of the Polovtsi (Kumans), Ugri (Magyars), Pechenegs, and related tribes, in the ninth and tenth centuries. Whatever the name under which they came, they were, so far as can at present be discerned, all of Tartar or Turkish or Ugro-Finnic extraction, which means mixtures in differing proportions of the white (western Asiatic) and

[1] These were the non-Slavic Bolgars from the Volga, who eventually left their name to the Slavonic state south of the Danube.

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yellow-brown (Tungusic or Mongolic) racial elements. All were more or less nomadic and destructive, bent on spoliation, and on penetration toward the richer more southern and central parts of Europe, rather than on the conquest of Russia and the establishment there of a permanent new home; though some, such as the Polovtsi, Pechenegs, and others, became for a greater or less period settled in Russian territory before they disappeared. Taken collectively, these invasions resulted in a great retardation of the settlement of the southern parts of Russia by the Slav people, as well as in seriously hindering the cultural advance of the Russians; but the hordes did not colonize or mix readily, except through captives, and while some remnants of them and mixtures were doubtless left scattered over the territory, they made no great impression on the eventual Russian population.

Meanwhile, since as early as the times of Herodotus, we began to hear of tribes such as the "Budini," which reached far eastward in Russia, and may have been Slavonic. In the fourth century, according to Jordanes,[1] the historian of the Goths, Hermanric conquered the Veneti, or Vends, which was the earlier generic name for the Slavs, the term "Slav" not appearing even in the Byzantine chronicles until after the close of the fifth century. In Jordanes' time, or about the middle of the sixth century, the "populous race of the Veneti dwell near the left ridge of the Alps (Carpathians) which inclines toward the north and beginning at the source of the Vistula, occupying a great expanse of land. Though their names are now dispersed amid various clans and places, yet they are chiefly called Sclaveni and Antes. The abode of the Sclaveni extends from the city of Noviodunum and the lake called Mursianus to the Danaster, and northward along the Vistula. The Antes, who are the bravest of these peoples dwelling in the curve of the sea of Pontus, spread from the Danaster to the Danaper, rivers that are many days' journey apart." In another part of the work of the same author we read that these new people "though off-shoots from one stock, have now three names, that is, Veneti, Antes and Sclaveni." And "they now rage in war far and wide, in punishment for our (*i. e.*, Goth) sins," though once "all were obedient to Hermanric's commands."

During the ninth and tenth centuries many Slav settlements or outposts are mentioned in Russia as far north already as the Tchoud

[1] Mierow's version, Princeton, 1908.

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country (Esthonia), and as far west as the region between the Don and the Volga. Since the sixth and seventh centuries, also, we have historical data indicating extensive and in a large measure solid Slavic population reaching from the Balkans to Pomerania, and from Bohemia and the Elbe over Poland, Galicia and western Russia. This population, the vital center of which seems to have been the territory about and north of the Carpathians, is subdivided into numerous "families," tribes, or nations, which form as yet no great units. The term Slavs (probably from slavit, to praise, to glorify) as applied to these people may possibly have originated from their frequent usage in personal names of the terminal "slav," as in Jaroslav, glorifying the spring, Mstislav, extolling revenge, Boguslav, praising God, etc., which at that time was common to the whole people. Their earlier history and origin were lost in the mists of uncertainty, and their western contingents were not always clearly differentiated from the Germanic tribes. Also, they bore as yet none of those names under which they later became distinguished.

The political unit of Russia did not come into existence until the ninth century. At that time, according to the "Ancient Chronicle" of Nestor, the first Russian historian, there lived in the regions along and west of the Dnieper and farther northward, the following Slav tribes: On the Ilmen, the Novgorodci; on the upper Dnieper, Dvina and Volga, the Krivitchi (who may, however, have been partly of Lithuanian origin); between Dvina and Pripet, the Dregovitchi; southeast of these, the Dierevliane (the woodsmen); from Teterev to Kiev, the Poliane (those of the flatlands); on the Bug, the Duliebi and Buzhane; on the Dniester and Bug, the Tivertsi and Ulitchi; in Volhynia, the Voliniane; on the Sozha, the Radimitchi; on the Oka, the Viatitchi; and on the Desna and Seim, the Severiane (the northerners).

These tribes or local groups, however, were not yet united, and, according to Nestor, their dissensions finally led an influential elder to propose that they call some prince of foreign blood, of whom none would be jealous, and under whom, in consequence, it might be possible to merge all the subdivisions into one strong Slav state. The wisdom of this advice was acknowledged and the envoys called on certain princes of the Variags or Varangians, of Scandinavian origin. These were three brothers, the oldest of whom was named Rurik. They were offered the privilege of becoming the rulers of the tribes and, accepting, the Slav territories were divided among them; and the two younger brothers dying, perhaps not by natural

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means, shortly afterward, the entire nation became united under Rurik. But in the opinion of some modern Russian historians the real facts were that the Slav and Tchoud tribes, suffering from repeated incursions of the much better armed and trained Scandinavians, hired other "Variags" for their protection and these ended by usurping the ruling power over the tribes. Such was the birth of Russia. The term "Rus" appears at about the same time. It is probably derived from "rusij," fair-haired, blond, and was applied at first to blond non-Slavic elements, but after a time came to be used by foreigners and then by natives for the whole new nation. The Variags played a prolonged but subordinate and steadily diminishing rôle in the Russian annals until they eventually disappeared, leaving little behind except some of their given names such as Oleg, Olga, etc., which are in frequent use among the Russians to this day.

After Rurik the bulk of Russian history consists of internal accommodations, not seldom violent; of defensive or retaliatory external wars; of endless, fluctuating life-and-death struggle in the south and southeast with the Asiatic hordes; and of unceasing extension of the prolific Slav element in all directions where resistance was not insurmountable. This was particularly toward the northeast and northwest, where gradually the Meria, Mordva and other primitive Finnic tribes were replaced or in a large measure absorbed.

Notwithstanding the many internal and external vicissitudes of the country, its elementary spread continued until 1226, when all southern Russia fell under the greatest plight that has yet afflicted it, through the final and overwhelming Tartar or "Mongol" invasion. This invasion covered all present Ukraina and beyond, and thence extended over parts of Poland, Galicia, and Hungary. The southern Russians were slaughtered in large numbers and subjected to the Tartar yoke, or forced to flee. The southern and southwestern parts of Russia became seriously depopulated and were occupied by the roaming Tartars of the "Golden Horde"; and Russia as a whole suffered from the effects of the invasion for over two centuries. The invaders established themselves over much of the southern part of the country, particularly in Crimea, where they became a fixed element and developed a political unity of their own, which remained ruled by their Khans until 1783, the year of their final submission to the Russians. To this day, however, a large part of the population of Crimea is more or less Tartar.

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Long before this, however, the Russians spread over all the more northern regions of their present European domain, to and beyond the Urals, and even over Siberia. Expansion into the latter deserves a few words by itself.

Up to the sixteenth century the vast region now known as Siberia was peopled exclusively by native tribes, of Ural-Altaic or Mongolian extraction or with Mongolian admixture. They were all more or less nomadic and in a primitive state of culture. There was never any political unity; and many of the tribes whose forefathers had probably participated in the westward invasions lapsed gradually into a numerically and otherwise weakened condition. It was such a state of affairs which awaited the ever progressing Russian tide.

The first Russians crossed the Urals as early as the eleventh century, but this led to no consequences of importance. The conquest of Siberia took place in 1580. Yermak, a Don Cossack in disgrace, invaded the vast territory with 1,636 followers, and this handful of men practically secured the conquest of a territory considerably more than twice as large as the whole of Russia in Europe. Within eighty years after that the Russians reached the Amur and the Pacific; and the rest is merely a history of a gradual disappearance of the natives and of Russian immigration.

The cultural progress as well as the racial aspects of southern Russia was affected more by the great Tartar invasion of the thirteenth century than by any or perhaps all the previous ones. The descendants of the Tartars, together with other remnants, are found to this day in numbers along the Volga and some of its tributaries, and north of the Sea of Azov, as well as in Crimea and the Caucasus; while some Tartar blood can be traced in not a few Russian families. The effects of the resulting ethnographic changes are felt even now and have been utilized by the enemies of Russia against the interest of the country. This relates especially to the region now known as Ukraina (the "border province") or Little Russia. No such subdivision existed before this last Tartar invasion, and the region of Kiev, now the capital of Ukraine, was the old center and heart of Russia. The Tartar massacres in part depopulated the region, and created a terror which resulted in large numbers of the people fleeing westward into Galicia and Polish territory. There are differences of opinion as to how great the depopulation really was, but that it was severe, though perhaps not complete, is indisputable. As all this is of particular importance at the present

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time it may be best to quote here from one of the foremost modern Russian historians who gave this question particular attention[1]:

The exodus from Kievan Rus took two different directions, and flowed in two different streams. Of these streams, one tended towards the West—towards the region of the Western Bug, the upper portions of the Dniester and Vistula, and the interior districts of Galicia and Poland . . . This westward movement had a marked effect upon the fortunes of the two most outlying Russian provinces in that direction—namely, Galicia and Volhynia. Hitherto their position in the political hierarchy of Russian territories had always caused them to rank as lesser provinces, but now Galicia—one of the remote districts allotted only to *izgoi* princes of the house of Yaroslav—rose to be one of the strongest and most influential in all the southwestern region. The "*Slovo o Polku Igorově*" even speaks of the Galician Prince of its day (Yaroslav the Prudent) as "rolling back the gates of Kiev," while, with the end of the twelfth century, when Roman, son of Mstislav, had added the province to his own principality of Volhynia, the combined state waxed so great in population and importance that its princes became sufficiently rich and powerful to gather into their hands the direction of the whole southwestern region, and even of Kiev itself. In fact, the Ancient Chronicle goes so far as to describe Prince Roman as "the Autocrat of all the Russian land." Probably, also, this inrush of Russian refugees into Galicia and Poland explains the fact that annals of the thirteenth and fourteenth centuries frequently refer to Orthodox churches as then existing in the province of Cracow and other portions of the Southwest.

The same migratory movement may serve to throw light upon a phenomenon of great importance in Russian ethnography—namely, the formation of the Little Russian stock. The depopulation of Dnieprian Rus which began in the twelfth century was completed during the thirteenth by the Tartar invasions which took place between the years 1229 and 1240. For a long period after the latter date the provinces of ancient Rus, once so thickly peopled, remained in a state of desolation. A Catholic missionary named Plano Carpini, who traversed Kievan Rus in 1246, on his way from Poland to the Volga to preach the Gospel to the Tartars, has recorded in his memoirs that, although the road between Vladimir in Volhynia and Kiev was beset with perils, owing to the frequency with which the Lithuanians raided that region, he met with no obstacle at the hands of Russians—for the very good reason that few of them were left alive in the country after the raids and massacres of the Tartars. Throughout the whole of his journey across the ancient provinces of Kiev and Periaslavl, he saw countless bones and skulls lying by the wayside or scattered over the neighbouring fields, while in Kiev itself—once a populous and spacious city—he counted only two hundred houses, each of which sheltered but a few sorry inmates. During the following two or three centuries Kiev underwent still further vicissitudes. Hardly had she recovered from the Tartar attacks delivered prior to the year 1240 when (in 1299) she was ravaged afresh by some of the scattered bands of Polovtsi, Pechenegs, Turks, and other bar-

[1] A History of Russia, by V. O. Kluchevsky, late professor of Russian History of the University of Moscow, 3 vol., 8°, Lond., 1911-13; I, 194-196.

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barians who roamed her desolate frontiers. In that more or less grievous plight the southern provinces of Rus remained until well-nigh the middle of the fifteenth century. Meanwhile Southwestern Rus (now beginning to be called in documents of the period "Malaia Rossia" or "Little Russia") had been annexed to the combined state of Poland-Lithuania; so that of the Empire thus formed the region of the Middle Dnieper—*i. e.*, old Kievan Rus—had now become the southeasternmost province or Ukraine. With the fifteenth century a new colonisation of the Middle Dnieper region began, to which two circumstances in particular contributed: namely, (1) the fact that the Steppes of the South were becoming less dangerous, owing to the dispersal of the Golden Horde and the rise of Muscovite Rus, and (2) the fact that the Polish Empire was beginning to abolish her old system of peasant tenure by quit-rent in favour of the *barstchina* system, which tended towards serfdom and therefore filled the oppressed rural population with a desire to escape from the masters' yoke to a region where they might live more freely. These two factors combined to set on foot an active *reflex* exodus from Galicia and the central provinces of Poland towards the southeasternmost borders of the Polish Empire—*i. e.*, towards the region of the Dnieper and old Kievan Rus. The chief directors of this movement were the rich Polish magnates, who had acquired enormous estates in that part of the world, and now desired to people and reclaim them. The combined efforts of the immigrants soon succeeded in studding these seignorial domains with towns, villages, hamlets, and detached homesteads; with the result that we find Polish writers of the sixteenth century at once exclaiming at the surprisingly rapid movement of colonists towards the Dnieper, the Dniester, and the Eastern Bug, and lamenting the depopulation of the central provinces of Poland to which that movement had given rise. All things considered, there can be little doubt that the bulk of the settlers who took part in the recolonising of Southern Rus were of purely Russian origin—that, in fact, they were the descendants of those very Russians who had fled westwards from the Dnieper during the twelfth and thirteenth centuries, and who, though dwelling since among a Polish and Lithuanian population, had, throughout the two or three intervening centuries, retained their nationality intact.

The language of the new population of Ukraina developed certain dialectical differences, while in other parts of Russia it was being gradually affected in other ways by association with the Lekhs (Poles), Lithuanians, and the Finnish tribes. In addition there arose in the course of time, as could hardly be otherwise when the great territories over which the Russian people were spread are taken into consideration, some differences in the richness and nature of folk tales, folk poetry, dress, etc.; differences the perception of which by the Ukrainians has for long before the present war been assiduously fostered by the Germans and Austrians, on the basis of their cherished, old *"divide et impera"* principle. Finally this region has received, together with Bessarabia, the mass of the Jewish

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immigration into Russia, which could not but add to its separatism, for which anthropologically and outside of the Jews there is no substantial reason.

At about the same time that the terms of Ukraina and Mala Rossia ("smaller Russia") came into vogue, there also began to appear those of Velika and Biela Rossia ("Greater, and White Russia"), and those of Malorusi, Velikorusi and Bielorusi, which are applied to their respective populations. These terms, like those of Ugro-Rusi, Rutheni, Gorali, etc., are partly conventional, partly environmental or geographical. The language and habits of the Bielorusi, who occupy the westernmost part of Russia north of Ukraina, were gradually affected, though on the whole to but a moderate extent, by their relations with the Poles and Lithuanians; while those of the Velikorusi or "Moskvali" (Muscovites) who spread over central, northern and eastern Russia, were modified somewhat in turn by their associations with the Tchouds, Finns, and various other people of the Finno-Ugrian stock with whom they mingled and whom they freely absorbed.

Such were in very brief the origin and nature of the three great subdivisions of the Russian people with which we meet to-day. The resulting differences between them, both cultural and somatological, are smaller than those between some of the tribes of Germany, and had it not been for Russia's enemies in whose interest it was to foment dissensions in the population, they would have remained harmless and with growing culture would have disappeared. But powerful united Russia, such as it could have been and with the help of the Allies may yet be, was an insupportable nightmare to both Austria-Hungary and Germany.

From the purely anthropological standpoint, the Russians belong overwhelmingly to the great type of Slavs in general, which in turn can hardly be distinguished from the Alpine type. But, like all large nationalities, the Russians show in various localities more or less marked traces of admixture with the Nordic peoples on the one hand, and on the other with the Finnish, Turkish, Tartar, and Iranian tribes.

The modern Russian population represents a physically strong and very prolific stock, freer as yet from degenerative conditions than perhaps any other of the larger European groups. The total population of European and Asiatic Russia counted collectively at the commencement of the war 178,000,000, living in a continuous mass and increasing yearly, through the natural excess of births over deaths

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by over 1.67%, the highest rate of any more important white population. The Slavs constitute approximately 75% of this population—81% in European Russia and Poland, 40% in Caucasus, and 85% in Siberia. As to the proportion of the separate Slav and other racial elements, we have the following interesting and trustworthy estimates by Professor Niederle[1] of Prague, the foremost authority on Slav matters in general:

ETHNOGRAPHIC DISTRIBUTION OF THE POPULATION OF RUSSIA

	European Russia	Russian Poland	Finland	Caucasus	Siberia	Central Asia
	per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*
Russians (Slavs)	80.0	6.7	0.2	34.0	81.0	8.9
Poles	1.2	71.8	....	0.3	0.5	0.1
Lithuanians	3.0	3.3	....	0.1	0.2	....
Finns	3.6	0.1	86.7	0.1	1.1	0.2
Germans	1.4	4.3	13.0	0.6	0.1	0.1
Jews	4.0	13.5	....	0.4	0.5	0.1
Caucassians	....	....	....	26.2	....	....
Armenians	0.1	....	....	12.0	....	0.1
Turko-Tartars	4.9	0.1	....	20.2	8.3	85.5
Mongols	0.2	....	....	0.2	6.2	0.2
Others	1.6	0.2	0.1	5.9	2.1	4.8

THE NON-RUSSIAN RACES OF EUROPEAN RUSSIA

These include the Poles, the Lithuanians, the Tchouds and Finns, the remnants of the Finno-Ugrian tribes of the interior, the Laps and the Samoyeds, the Tartars, the tribes of the Caucasus, and finally the immigrant Jews and Germans. In the first place, however, a few remarks may be appropriate here regarding the Cossacks.

The Cossacks.—The term Cossack has in the course of time become surrounded, even in Russia itself, with a semi-romantic and heroic halo, which is not wholly undeserved; but the term itself is seldom properly understood. The Cossacks of the present day may be defined as a special class of irregular, privileged cavalry. The Kazaki (the Russian form of the term) of the fifteenth and sixteenth centuries were in part a class of irregular agricultural help "who possessed neither a definite avocation nor a settled domicile," in part frontiersmen and adventurers, along the southern boundaries of the Russian settlements. The word Cossack came to signify, in Kirghiz, a cavalier, in Tartar a freebooter, in Turkish a light-armed soldier; they were all this and more. They were

[1] Lubor Niederle: Slovanský Svět, 8°, Praha, 1910; abstr. in Smithson. Rep. for 1910, pp. 599-612, with a map.

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of Russian origin; but being always settled on the outskirts of the advancing empire and continuously in struggle or contact with the Turkish and Tartaric hordes, their blood has received in the course of time more or less admixture. Some of the Cossacks now are recruited in the main from non-Russians.

The fighting Cossacks as far as traceable originated during the fourteenth or fifteenth century from among the Russian refugees before the invading Tartars. They settled on certain islands in the Dnieper River, were hunters, fishermen, and Tartar fighters, and gradually developed into a strong, bold, and resistant group, loving the hard frontier life with its liberties and dangers. Similar bodies developed all along the border of the steppes and became the terror of the Tartars and Turks, though frequently also a trouble to the Poles and even Russians. Their military value was, however, generally recognized in time and led to the regulation and extension of the Cossack system over southern Russia, Caucasus, Central Asia, and Siberia, until the Cossack became the regular forerunner, scout, and protector of the Russian armies and Russian colonies from the Danube to the Pacific Ocean.

There exist to-day about twelve subdivisions of the Cossacks, the best known of which are those of the Don, Orenburg, Ural, and Siberia. Their free institutions, interesting customs, and especially their exploits in the conquest of Siberia, the Napoleonic invasion, etc., made their name justly famous.

The Poles.—The Poles, the old "Lekhi" and "Poliane," are Slavs derived in prehistoric times, like the Russians, Czechs, etc,, from the common autochthonous Slav nucleus north of the Carpathians. They are admixed somewhat with the Russians and to some extent also with the Lithuanians; slightly, perhaps, also with nordic and other elements. At the commencement of the war they numbered in European and Asiatic Russia approximately eleven millions, almost nine-tenths of which were in Russian Poland.[1] Notwithstanding their thousand years of agitated history, they are still a "young" stock, full of energy, ability and spirits, and as prolific as the Russians.

The Lithuanians.—The Lithuanian territory lay originally along the Baltic, between the Visla (Vistula) and Dvina, and at the time of their maximum power their influence reached from the Gulf of Riga to Ukraina. They extend at present from Poland and east Prussia to near Riga.

[1] Those of Austrian-Poland counted in 1914 approximately 4,500,000; those of German-Poland approximately 4,000,000.

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The Lithuanians are a strain of people whose racial identity has been a matter of considerable controversy. Through their ancient tongue, which has many similarities with the Sanscrit and with the Slav, they are related most closely to the latter, but in physical type while resembling the Poles and Great Russians they also approximate in part the Scandinavians on account of more frequent blondness. In all probability they have an admixture of all these elements. They are subdivided into three main branches, the Borussians (Prussians), the Latvis or Letts, and the Litvini or Lithuanians proper. Their total number at present is slightly over four millions, about equally divided among the Letts and Lithuanians. The Borussians, whose home was in eastern Prussia, were almost destroyed by the Germans in the thirteenth century, under the pretext of Christianization. In the words of one of the German writers himself (Schleicher, 1852), "Never has a pagan people, good, brave and generous, been maltreated in a more cruel manner than the eastern Prussians . . . . The history of their death struggle against the Teutonic order must be mentioned as one of the most sinister episodes of mankind." A few remnants of them still exist in Eastern Prussia.

The Lithuanians, whose ethnographic limits are ill-defined, have been connected with Russia since 1797.

The Livonians.—The true Livonians are practically extinct. Their country lies east of the Gulf of Riga and is now occupied partly by Letts and partly by Esthonians. Their language belonged to the Finnish or Finno-Ugrian family, and they were doubtless closely related to the Esthonians.

The Tchouds or Esthonians are a Finnish tribe occupying a larger part of the territory between the Gulf of Riga and the Gulf of Finland. They have been united with Russia since 1030, but were tributary to the Russians much earlier. They number at present only between five and six hundred thousand persons. Efforts by the Germans since the thirteenth century at "Christianizing" Livonia and Esthonia, as they did Prussia, have been a failure, and "the Ehsts and Letts openly display their traditional hatred against the invaders."

The Finns.—The Grand duchy of Finland was ceded by Sweden to Russia in 1809. Its population consists at present of approximately 2,700,000 Finns, 350,000 Swedes, 8,000 Russians, 2,000 Germans, and 1,700 Laps. The Finns represent the westernmost extension of the Finno-Ugrian Asiatic stock; but while retaining their language their blood, especially in the south, has become much mixed

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with that of the Scandinavians. The more northeastern subdivision of the Finns, known as the Karelians, are better preserved.

The Laps and Samoyeds.—These are the most Mongolic-like natives of European Russia and are undoubtedly of Asiatic origin. Their numbers are insignificant—collectively less than 20,000 individuals. They occupy the northernmost limits of the Russian territory, the Laps extending into Scandinavia.

Finno-Ugrian tribes of the interior.—These are located principally on the middle Volga and the Kama, and represent the dwindling remnants of the primitive native populations that once covered much of central and eastern Russia. They have long been without any political individuality and are in a more or less advanced stage of absorption into the Russian population. They are known principally as the Mordva, Tcheremis, Voguls and Votiaks.

The Turko-Tartars.—Of these there are approximately seven millions in European Russia and the Caucasus. They are divided into the Crimean Tartars, Kazan Tartars, the Bashkirs, the Tchuvash and the Kirghiz, with many minor units. They still occupy or wander over a large portion of southeastern Russia and except within the diverse groups have no political or racial cohesion.

Caucasus.—This region since ancient times has been the eddy and refuge of remnants of nations, and there are in its fastnesses many interesting units which it is difficult to classify. By far the strongest element of the Caucassian population to-day, however, is the Slav (approximately 40% of the total), which is followed by the Turco-Tartar, Georgian, and Armenian. The total population of Cis- and Trans-Caucasia may be estimated at present at something over 13,000,000.

Siberian Natives.—To-day Siberia or more properly Asiatic Russia, possesses nearly eleven million inhabitants, considerably less than one-tenth of whom are non-Russians. Of these approximately 500,000 are Turko-Tartars, 300,000 Mongols, 70,000 Tungus, and 35,000 Ghiliaks, Chukchis, Koriaks, Yukaghirs, Kamchadals, Eskimo, and other smaller units; but all these groups are more or less mixed with the Russians,[1] and with the exception perhaps of those in Turkestan have no individualistic aspirations.

[1] An excellent ethnographic map of Siberia has been published, together with two large volumes of descriptive text, by the Dept. of Agriculture of the Russian government in 1914 ("Etnograficheskaia Karta Asiatskoi Rossii").

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THE JEWS

The Russian Jews are in the main, if not entirely, the descendants of refugees driven out of Germany during the persecution of the race in the middle ages. Some Jews penetrated into Poland and Lithuania as early as the middle of the eleventh century, but by far the larger number came later, particularly under the Polish king, Casimir the Great, whose wife was of Jewish extraction. From Poland they spread to Lithuania, Courland, and what is now Ukraina and Bessarabia. Peter the Great, and particularly Catherine II, opened to them the door of Russia.

A small branch of the Russian Jews are known as the Karaites. They differ in many respects from the remainder, are settled in Crimea where they speak Tartar and in western Russia where they speak Polish, and are principally agricultural. Their origin is still in dispute.

The total present number of Jews in European Russia before the war approximated 4,000,000, in Russian Poland 1,300,000, and in Caucasus 50,000. In addition there were about 50,000 in Siberia and Central Asia.

It is very interesting to note that physically the Russian Jews of to-day resemble to a considerable extent the Russians themselves (compare Maurice Fishberg, The Jews, N. Y., 1911). In Poland the approximation of the two types of population is much less apparent. The Karaites, whom some suppose to be the descendants of the Khazars, show anthropologically some affinity with the Tartars.

THE GERMANS

The total number of Germans in the lands under Russian dominion amounted at the beginning of the present war to a little over 1,800,000. They were scattered over practically all except the poorest parts of the empire, especially in the cities. In the Baltic provinces they were the privileged landed proprietors. In southern Russia and other agriculturally rich regions there were German agricultural colonies, some recent, some of older formation.

The German influx into Russia started in the sixteenth century and was especially active during the reign of Peter the Great. They came as artisans and merchants, frequently on invitation; and in 1762 they were invited to settle in some parts of southern Russia in agricultural colonies, which gradually and in a scattered way extended to the Don and the Caucasus. These colonies received special privileges, were practically self-governing, and fused but little with

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the Russians. During the latter half of the nineteenth century German colonization in important parts of Russia was, there are valid reasons to believe, favored if not directed by the German Government for economic and perhaps strategic reasons.

The German nobles and landed proprietors in the Baltic provinces date in the main from the time of the attempts by the German Knights to forcibly "Christianize" the natives of these provinces, though some were brought there later by the guileless Russians.

A study of the German relations with Russia shows that the latter has ever been a field for advancement and exploitation by Germany. By most Germans at home, the Russians, together with the rest of the Slavs, were looked upon as a desirable "fertilizer" for the German stock; but every care was taken that the Germans in Russia should not disappear in the Russian mass and thus weaken Germany to the advantage of her neighbor, the dreaded sleeping Samson, the Russian Slav.

CONCLUDING REMARKS

Leaving aside all details and localized ethnic peculiarities, we find that the racial problems of European as well as of Asiatic Russia, are relatively fairly simple. (1) We find over a large portion of the vast territory a thin substratum of Finno-Ugrians, who are of western Asiatic origin and carry with them varying traces of Mongolian admixture. (2) The southern portions of Russia from remote time constitute a broad avenue for the movement of Asiatic peoples in a westerly direction. These peoples are partly of Iranian, but in the main of Turko-Tartar derivation; and the Turko-Tartars like the Finno-Ugrians are mixed peoples, partly white and partly Mongolian. Their influence, both racial and cultural, on the country and its people is marked and in a measure persists even to the present day. (3) Along the Baltic we find Finnish tribes in the north and the Lithuanians, probably of mixed Slavic and Scandinavian composition, farther southward and westward. (4) All the rest of the great region is Slav, Polish in the west, Russian in the center and eastward.

It is eminently true that Russia is essentially a Slav country, which to-day is equally true of Siberia and in a large measure even of the Caucasus. In Central Asia the Russian element is still considerably exceeded by the Turco-Tartars.

From the anthropological standpoint, the Russian stock is well developed, virile, resistant, and full of potential force. It may

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truly be said to be the great human reserve of the European population. If it has not advanced in culture as much as the western and southern European nations, the causes if contemplated impartially are seen to have been not inherent or racial, but geographic and circumstantial. It must not be forgotten that Russia by acting from its inception as the buffer between the rest of Europe and Asia, and by becoming later the principal check of the Turk, has deserved a deep gratitude of the more western and more favorably situated nations.

What will be Russia's future? Perhaps the anthropologist may attempt to predict where others would hesitate.

The Russian Slavs taken collectively, count to-day over one hundred millions,[1] and they are increasing yearly, by the excess of births over deaths by 1,700,000. This rate of increase is greater than that of any other people in Europe except some of the other branches of the Slavs, and with the mass of the people belonging to the conservative simple-lived rural population, cannot be expected to become much reduced in the near future. Such a rate of increase of this otherwise strong and able portion of the white stock, means a biological momentum which in the end must prevail over all opposition. The Russian giant may have his Delilahs, internally as well as externally, but these will not be able to hold him forever. Russia cannot but have a future commensurate with her potential powers.

[1] See author's article on "The Slavs" in the Nov., 1918, number of the Czechoslovak Review, II, Chicago, 180-187.

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1918

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1918

INTRODUCTION

The more important of the explorations and researches in the field conducted or participated in by the Smithsonian Institution during the year 1918, are herein briefly described. While in many cases the work was considerably restricted by the world war, nevertheless results of importance to science were accomplished and considerable material was added to the natural history and ethnological collections in the United States National Museum. Nearly every branch of science is represented among these researches, including anthropology, ethnology, geology, botany, zoology, and astrophysics.

The work of the Smithsonian Astrophysical Observatory in measuring the amount of radiation from the sun is of increasing importance, as it is expected to make these measurements the basis of a new method of forecasting temperatures on the earth. The ethnological studies among the tribes of American Indians are of special interest as certain of these tribes are fast disappearing, in some cases only a very few persons surviving who remember the language, customs, and traditions of a once powerful people. This ethnological material is being recorded from the Indians themselves by members of the Bureau of American Ethnology and so preserved for future generations.

The brief accounts contained herein are largely written and the photographs taken by the investigators themselves.

GEOLOGICAL EXPLORATIONS IN THE CANADIAN ROCKIES

The geological explorations carried on in the Canadian Rocky Mountains by Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, which have been mentioned in the Exploration Pamphlet of the Institution for the years 1916 and 1917, were continued during the field season of 1918 for the purpose of ascertaining the geological structure of the Upper Bow Valley north of Lake Louise, Alberta, and later at the head waters of the Cascade River at Sawback Lake, and also to locate any possible occurrence of unusual beds of fossils at these places.

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Passing up the Bow River from Banff there is a beautiful view from Vermilion Lakes of the western slope of Rundle Mountain near Banff (fig. 2). To the north Mount Louis in the Sawback Range thrusts its pinnacles of upturned limestones far above timber-line (fig. 3). The pinnacles when seen from the north present a bold, strong sky-line (fig. 4).

Leaving the Canadian Pacific Railway at Lake Louise Station, the Bow Valley extends to the northwest parallel to the Continental Divide which forms its southwestern side. Bow Lake at the head

FIG. 2.—Southwest slope of Rundle Mountain, looking across Vermilion Lakes, 2 miles (3.2 km.) west of Banff. The mountain is composed of sloping limestones that form bold eastward facing cliffs. Photograph by Walcott, 1918.

of the valley is a beautiful sheet of water hemmed in by bald mountain slopes and cliffs on the west and north and by the mass of Mount Hector (11,125 feet) on the east. From the west numerous glaciers drain into the lake. The first one encountered is Crowfoot (fig. 5), which flows from the great Wauputek snow-field along the Continental Divide. Some of the smaller glaciers bring down an immense amount of broken and ground up rock which forms long slopes extending nearly to the edge of the lake (figs. 6 and 7).

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FIG. 3.—To the northwest of Banff, Mount Louis in the Sawback Range thrusts its pinnacles of upturned limestones far above timber line. Photograph by Walcott, 1918.

FIG. 4.—Pinnacles of Mount Louis seen from the north present a bold, strong sky-line. Photograph by Walcott, 1918.

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FIG. 5.—View from the west slope of Dolomite Peak, looking westward and southwestward across Bow Lake, which is 19 miles (30.4 km.) north-northwest of Lake Louise. In the center Crowfoot Glacier. To the left center Crowfoot Mountain, and in the distant left Bow Peak. To the right of the Glacier Mount Breese with a small glacier on its eastern slope. Photograph by Walcott, 1918.

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FIG. 6.—Small glacier in an amphitheater on the eastern slope of Mount Breese (see fig. 5) with a great talus slope that extends from the foot of the glacier nearly down to the waters of the lake. Photograph by Walcott, 1918.

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FIG. 7.—Panoramic view from the northeast ridge of Mount Thomson, looking south across Bow Lake. On the right above the lake Mount Breese, and on the left of it Crowfoot Mountain with the snow field of Crowfoot Glacier. At the foot of the Lake, Bow Peak and in the distance Mount Hector. To the left Mount Molar (see fig. 8). Photograph by Walcott, 1918.

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Figure 7 pictures Bow Lake as seen from the eastern slope of Mount Thomson. This view over the lake from the north shows the ridges on the right formed of Middle Cambrian limestones, while far away in the distance the snow-clad summit of Mount Hector is buried in the clouds. In figure 8 is shown a nearer view of Mount Molar, a beautiful example of horizontally bedded limestones, illustrating the manner in which the hard, evenly bedded limestones erode into domes and broad cylindrical masses.

FIG. 8.—Mount Molar (9,914'), a high mountain ridge to the east-southeast of Bow Lake. Photograph by Walcott, 1918.

There was fine trout-fishing at the lower end of Bow Lake, and we met with both deer and grizzly bear in the somewhat open valley at the head of the lake (fig. 9).

The snow-fields from which Bow Glacier flows are on the Continental Divide between the Bow Valley and the Upper Yoho Valley. The glacier flows down a gentle slope for a mile or more, and then breaks over a high cliff, as shown in figure 10. There are beautiful camping grounds on the shores of both Hector and Bow lakes, especially the latter. From one of these camps (fig. 11), geological sections were measured of the Cambrian rocks on the eastern slope of Mount Thomson.

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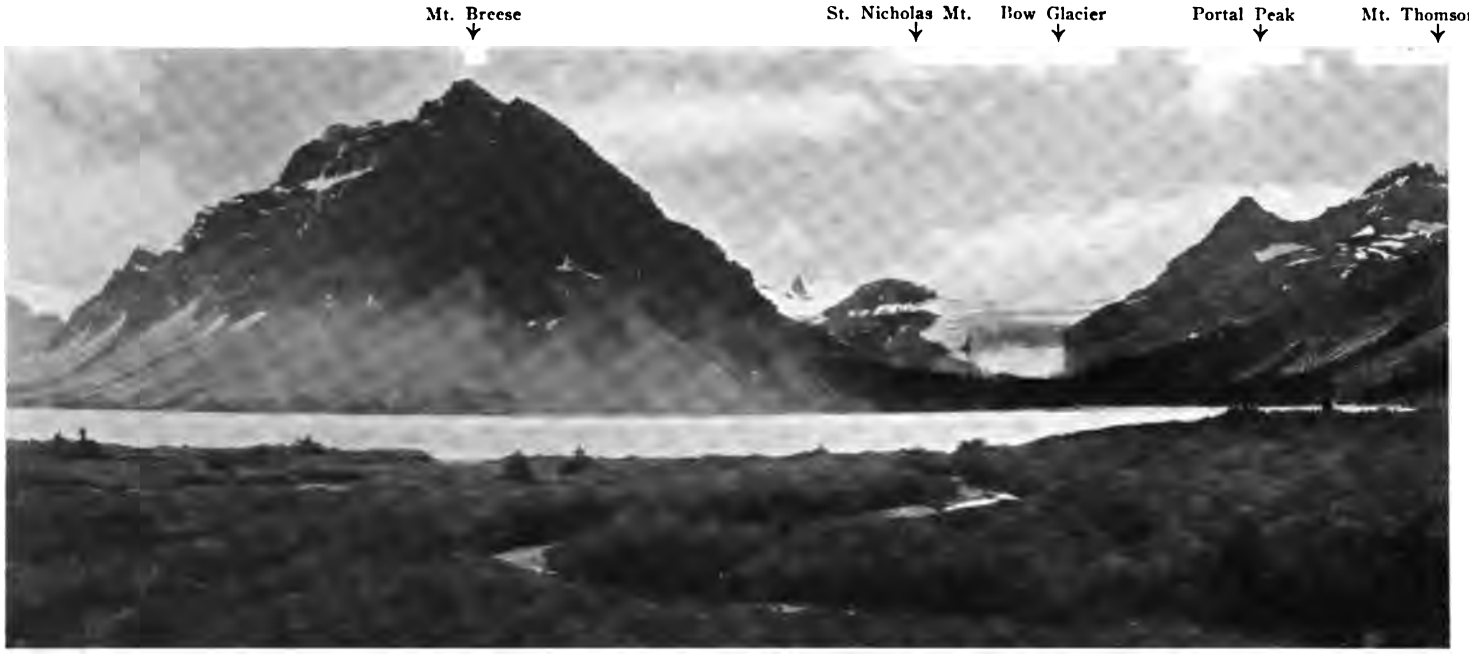

FIG. 9.—Panoramic view from the northeast end of Bow Lake. In the center Bow Glacier, and to the right Portal Peak and Mount Thomson. To the left of the glacier St. Nicholas Mountain, in the center Mount Breese. This view should be studied in connection with figure 7. Photograph by Walcott, 1918.

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FIG. 10.—View of Bow Glacier from our camp at the head of Bow Lake. This is a beautiful illustration of a glacier cascading or falling over a high cliff. Photograph by Walcott, 1918.

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FIG. 11.—Camp among the pines at the head of Bow Lake. This is a fine illustration of the forest growth at this altitude (6,420′). The rubber boots, landing net, and fishing rod were frequently used in the early morning and evening, as there were many trout in the nearby lake. Photograph by Walcott, 1918.

FIG. 12.—Looking through the trees at Bow Lake on a misty day when the horses were resting at camp. Photograph by Walcott, 1918.

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FIG. 13.—Illustration of the average slope of the mountain ridges on the sides of Bow Valley where the slope was not broken by cliffs. It is difficult when there is much loose stone to persuade the horses that it is safe traveling, but it is necessary to take them in order to transport camera, rifle, hammers, and the rubber coats which are needed almost daily in August. Photograph by Walcott, 1918.

FIG. 14.—We were accompanied in September by Vernon Wood, forest and game warden stationed at Mount Massive in the Bow Valley. This is a photograph of him with his family and their Rocky Mountain Park cottage, which is their home during the summer and also during the long, snowy winter, as the forest warden must be on guard and attending to his duties throughout the year. Photograph by Walcott, 1918.

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Fig. 15.—Peyto Glacier and Lake from the cliffs of the east shore of Peyto Lake on the northwest side of Bow Pass, 24 miles (39 km.) in an airline north-northwest of Lake Louise Station.
On the left above snow line the Continental Divide, Peyto snowfield or névé, glacier, ice-foot, terminal moraine, and flood plain. Photograph by Walcott, 1918.

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Bow Pass, four miles (6.4 km.) north of the head of Bow Lake, has been eroded by glacial action into a broad, park-like area, so that the passage over into the valley of the Mistaya River of the Saskatchewan River drainage is scarcely realized until steep slopes indicate the approach toward Lake Peyto. This beautiful lake, with a glacier at its head, as shown in figure 1 (frontispiece), drains into the Mistaya River. The bold escarpment on the north side of the

FIG. 16.—Pyramid Peak reflected in pond near Mistaya River, about 17 miles (27.2 km.) north of Bow Lake. Photograph by Walcott, 1918.

lake is continued to the north down the Mistaya River to the Saskatchewan. Several sections were examined along this front, which were found to be similar to the section at the head of Bow Lake.

Peyto Glacier is a very fine illustration of a complete glacier from the gathering field of snow on the Continental Divide to the ice arch at its foot. As shown in figure 1 (frontispiece), the flood plain at the foot of the glacier extends for nearly a mile to the edge of the lake, affording a fine illustration of the manner of filling in of glacial

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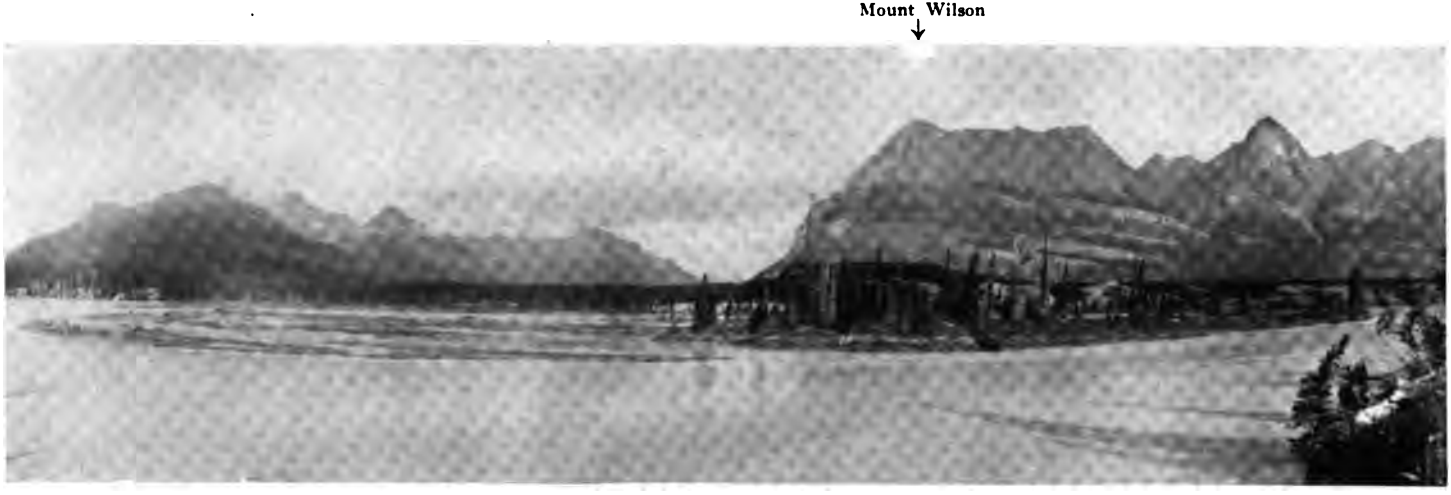

FIG. 17.—Panoramic view looking north across head of Saskatchewan River. The valley of the North Fork is shown on the left of Mount Wilson (11,000'). The Saskatchewan is here a large and rapid stream just below the union of the north and west forks. It is wonderfully picturesque, and on the mountains to the left we saw large numbers of mountain goats, some of which we were so fortunate as to obtain a photograph of. Photograph by Walcott, 1918.

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FIG. 18.—Group of mountain goats endeavoring to escape over a sharp ridge immediately in front of where Mrs. Walcott was watching for them. The one attempting to go around the point on the left is on the edge of a cliff about 50 feet above the river. The goat at the top is apparently attempting to prevent itself going over backward by throwing its head forward. Photograph by Walcott, August 5, 1918.

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lakes by the rock and dirt brought down by the glacier from the higher mountain slopes. A nearer view of Peyto Glacier is given in figure 15, and figure 16 shows Pyramid Peak, one of the peaks encountered in the Mistaya River Canyon.

The broad canyon valleys that unite at the head waters of the Saskatchewan River (fig. 17) are all carved by erosion out of the same type of Cambrian rocks as those exposed in the vicinity of Bow Lake, and also in the Bow Valley south of Lake Louise Station.

FIG. 19.—Skinning out mountain sheep shot above head of Sawback Lake on September 21. Photograph by Walcott, 1918.

At the close of the season a fine pair of mountain sheep, a black bear, one mule deer, a mountain goat, and a wolverine were collected, the skins and skulls being shipped to the National Museum. At a salt-lick on the west branch of the Saskatchewan River many goats were seen. Some of them in an attempt to escape observation were forced to pass over a sharp ridge directly in front of where Mrs. Walcott was sitting, with the result that she obtained an unusual photograph of five of them (fig. 18) as they were clambering over the apex of the ridge.

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FIG. 20.—Panoramic view looking across Sawback Lake eastward toward the Vermilion Range. The lake is about 16 miles (25.6 km.) in a straight line northwest of Banff, Alberta, Canada, and a favorite fishing grounds for the anglers of Banff. Photograph by Walcott, 1918.

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GEOLOGICAL AND PALEONTOLOGICAL FIELD-WORK

The field-work of the Division of Geology during 1918 was limited largely to the collection of material for the school and duplicate series and for the use of the Naval Experiment Station in a newly devised apparatus recently brought into use. In connection with the latter work, the head curator made two trips, one through the principal museums of the eastern United States, and subsequently, one extending from northern Georgia through western North Carolina. In addition to the material obtained for the Navy Department, a statement of which is included in a report to the National Research

FIG. 21.—Arriving at home on the trail at eventide, and looking over the horses before turning them out for the night. This camp, below Wolverine Pass, is in one of the most interesting localities in the mountains south of Lake Louise. Photograph by Walcott, 1918.

Council, there was secured a considerable amount of bauxite, staurolite crystals, and numerous specimens of other desired materials, such as columbite, pitchblende, albite, black mica, and quartz.

Dr. Martin, assistant curator of geology, U. S. National Museum, was detailed to spend two weeks in Virginia and Maryland making collections of material to illustrate the weathering and decay of the commoner types of rocks. A sufficient quantity of each phase of the process was taken to make up 100 sets intended for distribution

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primarily to such agricultural and other colleges as give instruction in rock weathering and soil formation. A series of from two to four specimens was obtained from each of the seven varieties of rocks showing the fresh and intermediate steps in the present stage of its decomposition. The types selected include granite-gneiss, diabase, gabbro, soapstone, sandstone, and limestone. The railroad cuts in the vicinity of North Garden and Chatham in Virginia, and Mount Hope and Washington Junction in Maryland, afforded, respectively, the granite-gneiss, diabase, gabbro, and sandstone, and the quarries at Alberene, Virginia, and Frederick, Maryland, yielded the soapstone and limestone. In every case the oxidation had proceeded sufficiently to result in the formation of reddish- or yellowish-brown soil, but in the case of the North Garden granite-gneiss, perfectly fresh rock could not be obtained. To supply this deficiency, a series of specimens from the granite-gneiss of the District of Columbia was included, although its weathering had not passed the stage of mechanical disintegration. Despite the fact that such materials do not readily lend themselves to exhibition purposes, several choice residual nodules of gabbro and diabase (so-called nigger heads) one to two feet in diameter were collected for Museum display.

In order to fill certain gaps in the ore and rock collections, Dr. Martin was also detailed to visit localities in Pennsylvania, New Jersey, and New York, and secure a quantity of material from each. Brandywine Summit, Pennsylvania, yielded some excellent cleavage fragments of orthoclase; Peekskill, New York, a select grade of emery rock; North River, New York, hand size pieces of abrasive garnet. From the dikes at Franklin Furnace and Beemersville, New Jersey, was secured a supply of uncommon intrusive rocks, camptonite and nepheline-syenite respectively. Both of these formations, as well as the peridotite, associated with the emery and the syenitic country rock of the garnet, were found to have suffered considerably from the action of the weather since glacial times, and appropriate specimens showing this process were collected incidentally for the study series.

During the field season of 1918, Drs. R. S. Bassler and C. E. Resser of the Division of Paleontology continued the search begun in recent years for large exhibition specimens to illustrate the various phases of structural geology and stratigraphic paleontology. Dr. Bassler

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began field-work in an investigation of the Cretaceous rocks of western New Jersey, where the prime object was to secure suitable exhibits of such economically important rocks of organic origin as glauconite or green sand, and calcareous marl. The green sand area in the vicinity of Vincentown, New Jersey, afforded the best results in fossil and rock specimens for both study and exhibition. The very incoherent green sand could not be obtained in masses of a size suitable for exhibition, but by the use of shellac a large piece was hardened sufficiently to be shipped to Washington without

FIG. 22.—Marl pit at Vincentown, N. J. Photograph by Bassler.

breakage. In the marl pits unusually well-preserved fossils were found scattered through an unconsolidated sand formation. Here specimens abound literally by the millions, and large numbers were collected by passing quantities of the sand through a fine-meshed sieve, the residue in this process usually consisting of nothing but well-preserved fossils. The amount of sand sifted is shown by the excavation seen in figure 22. The undulating line marks the irregular contact or unconformity between the Cretaceous marl formation and the overlying strata of more recent age. At the point B in this photograph the fossils occurred in especial abundance,

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cemented together and forming a limestone mass of such interest that several large pieces were dug out for exhibition in the Museum.

Dr. Bassler then proceeded to the Lancaster Valley of Pennsylvania where, in company with Dr. Resser, some days were spent studying the stratigraphy of the valley, and collecting minerals and fossils. Working in the region of highly metamorphosed rocks in southern Lancaster County, they were fortunate enough to secure intact the large mass of finely banded, crinkled limestone shown in figure 23, L. This illustrates, on a small scale, the folding to

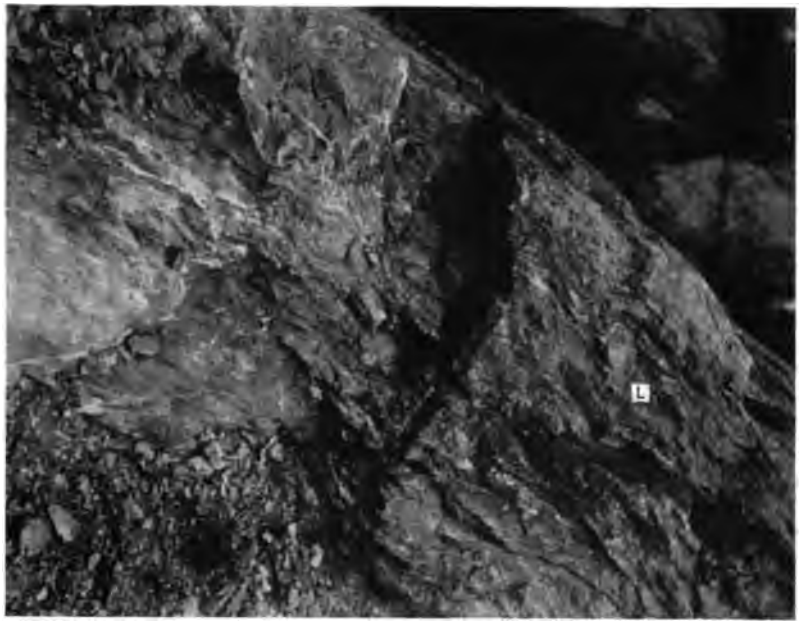

FIG. 23.—Crumpled Pre-Cambrian limestone, Southern Lancaster County, Pa. Photograph by Bassler.

which the earth's crust has been subjected and forms a much needed addition to the exhibits. Proceeding to York, Pennsylvania, an effort was made to determine the stratigraphy of that area from which numerous Lower Cambrian fossils had been collected for the Museum in former years. An idea of the general structure was obtained, but the stratigraphic details were worked out by Dr. Resser on a later trip.

The east front of the Alleghany Mountains was then visited by Dr. Bassler in an effort to obtain exhibition specimens illustrating fault-

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ing and its accompanying phenomena. In western Maryland a fault passing through a Silurian conglomerate was located. The conglomeratic layer itself at this place was composed of small, rounded pebbles of pure white quartz, forming an interesting educational object in itself, but along the fault zone the conglomerate had been broken into angular fragments and recemented together into a hard rock. In one case this recementation had been caused by silica and in another by iron ore. Large examples of both kinds of this fault breccia, as it is known technically, were quarried out. Fortunately,

FIG. 24.—East front of Alleghany Mountains, Western Maryland, showing fault zone at C. Photograph by Bassler.

as shown in figure 24, this fault zone (C) outcropped along a good country road, making the problem of quarrying and transportation easy.

In each of these areas photographs of the occurrence of these specimens in nature were secured so that the explanatory exhibition labels can be illustrated. The object of displaying such specimens is not simply to illustrate their geological or paleontological features, but to show in the same exhibit a portion of geological history involving at least several distinct events.

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Following this Appalachian work, Dr. Bassler spent some days in central Kentucky and eastern Indiana searching for certain exhibits. In Kentucky he located a layer of limestone which had been so carved out by underground water that it could be used to illustrate the formation of a cave in miniature, and a suitable piece was quarried out. Certain fossil faunas which were much needed to complete the Museum's paleontological material from this area were also secured. The main object of the work in Indiana was to obtain a large slab of limestone composed entirely of certain characteristic brachiopods known to all beginners in paleontology, frequent requests for such exhibits having been made by students visiting the Museum. After a week of search, two large, well-preserved slabs of this kind were found, but in an area some miles from a railroad. Upon endeavoring to have them transported to a freight station it was found impossible to procure help of any kind. These two specimens were therefore buried deep enough to insure their safety until such time as they can be shipped to Washington.

FIG. 25.—Exposure of Olenellus shale and Corynexochus limestone, north of York, Pa. Photograph by Resser.

Dr. Charles E. Resser spent a part of his vacation studying the detailed stratigraphy of the Lower Cambrian deposits of the Lancaster and York valleys of Pennsylvania. He found that the lowest

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sedimentary rocks of the region were massive, unfossiliferous limestone probably of Pre-Cambrian age, with a great erosional unconformity at their top. Immediately following this unconformity is an arenaceous limestone several feet thick containing the *Corynexochus* fauna hitherto believed to be of Middle Cambrian age. Following this bed, in apparently normal succession, are the well-known Lower Cambrian shales containing *Olenellus* and other trilobites. In figure 25 the point of contact between the two Lower Cambrian formations is indicated at C. Collections of two faunas of Lower Cambrian age were secured during these studies.

FIG. 26.—Open iron ore pit at Cornwall, Pa. Photograph by Resser.

Dr. Resser also spent some days in collecting mineral specimens from the celebrated ore banks at Cornwall, Pennsylvania, a locality famous for its well-preserved minerals, but unfortunately poorly represented in the Museum collections. These ore banks are in the hills between Lancaster and Lebanon counties and, as they have been worked since 1853, they are now great open pits from which the minerals can be obtained. The ore is the iron oxide magnetite, formed along the lines of contact of an igneous mass intruded into Paleozoic limestone. The magnetite often occurs well crystallized, but the mineralogical interest of the locality lies in the minerals of copper, iron, and magnesium silicates which were formed with the magnetite. The photograph (fig. 26) shows the arrangement of

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rocks in one of the open pits with the ore bed (O) at the bottom, above this the Early Paleozoic limestone (P), and capping the limestone, the red beds of Mesozoic age (M).

FIELD-WORK OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY

As usual, for some years past, the Astrophysical Observatory maintained its observing station on Mount Wilson and the work was in the hands of Mr. L. B. Aldrich. As heretofore, the principal object was to follow by accurate measurements the variations in the radiation of the sun as that would be found if one were on the moon, for example, outside the earth's atmosphere. The season did not prove particularly favorable for this work on account of unusual cloudiness. Nevertheless, Mr. Aldrich made many solar-constant observations that will be unusually valuable on account of the possibility of comparing them with similar observations made in South America, which will be related below.

It happened that a station of the U. S. Aviation Service was located near Mt. Wilson, at Arcadia, and military balloons not infrequently passed up through the layer of fog which often covers the San Gabriel Valley, lying between Mount Wilson and the sea. It occurred to Mr. Aldrich to take advantage of this condition of affairs to make a measurement of the reflecting power of such a great layer of fog with a view to the applicability of such measurements to a consideration of the temperature of the planets Earth and Venus, both of which are to a large degree covered with clouds. We have at the Astrophysical Observatory an instrument called the pyranometer, devised by Messrs. Abbot and Aldrich for the purpose of measuring the heating effect of radiation received from a whole hemisphere. For example, the heat from the sun and sky combined, or from the sun alone, or from the sky alone, as it falls upon a horizontal surface may be determined by this instrument. Mr. Aldrich's plan, therefore, was to expose the pyranometer upright to the sun and sky combined, and inverted to the radiation coming up from the layer of fog. For this purpose he needed a support for the pyranometer above the fog, and such a support he thought might be furnished by a military balloon.

With the approval of General Kenley the investigation was made on a favorable day in September, when the upper and lower surfaces of the fog lay respectively about 2,800 feet and 1,000 feet above the ground. Two officers and 50 men being detailed to aid

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Mr. Aldrich, one of the officers went up with the balloon, which carried the pyranometer suspended inverted underneath its basket, and exposed the apparatus repeatedly from about 7 o'clock in the morning until about 11 o'clock. The measurements were recorded by Mr. Aldrich on the ground by the aid of communicating wires carrying the currents of electricity set up by the heat of the rays received from the fog upon the instrument.

The measurements were singularly concordant and satisfactory, and gave as the mean reflecting power of the fog during the interval from 7 until 11 o'clock 78 per cent. No apparent change due to the change of the height of the sun during that time was observed. However, it is hardly questionable that if the measurements had been made nearer sunrise the reflecting power of the fog would have been

FIG. 27.—Smithsonian Observatory at Calama, Chile.

found somewhat greater. Accordingly, we must suppose that if there should be a planet completely covered with smooth clouds it would reflect upwards of 78 per cent of the solar rays otherwise available to heat its surface. In the case of the earth, the cloudiness is about 50 per cent, so that if the clouds were as smooth on their surface as the clouds observed by Mr. Aldrich, the result would be that they would reflect away about 39 per cent of the solar rays and make them ineffective to warm the earth. Taking this result in connection with the consideration of the other parts of the earth's surface, it appears that the reflecting power of the earth as a whole for solar rays of all wave lengths should be in the neighborhood of 43 per cent.

As stated above, the measurements of the solar radiation at Mount Wilson have unusual value this year on account of the simultaneous

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measurements being made at Calama, Chile, under the direction of Mr. A. F. Moore, assisted by Mr. L. H. Abbot. The outfit there is the same that was used by them during the previous year at Hump Mountain, in North Carolina. The present station was chosen as the most cloudless one to be found upon the earth, and they have been able to observe about 75 per cent of the days since the 27th of July,

FIG. 28.—The Coelostal, Pyrheliometers, and Theodolite.

FIG. 29.—Part of the Spectro-Bolometer.

when the measurements began. For long periods of time, as, for example, the period from the middle of November to the middle of December, there was not a single day lost, although this required that the sky should be perfectly cloudless for about three hours, either in the early morning or the late afternoon. Notwithstanding the great number of favorable days for the observations, the records

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of meteorological observations there in former years led us to hope for an even larger proportion of favorable sky conditions. However, in many parts of the world the past two years have been exceptional in their weather and it is to be expected that these exceptional conditions affected the weather of the Nitrate Desert of Chile as well. We therefore hope that in future years even better results may be obtained than now.

The purpose of the work is to follow the variations of the sun and to lay a foundation for the application of such measurements to the prediction of terrestrial temperatures. That branch of the investigation has been taken up by Dr. H. H. Clayton of the Meteorological Service of Argentina. Dr. Clayton has studied the correlations

FIG. 30.—Recording Observations.

between the solar-constant results and the temperatures of Argentina and he is quite enthusiastic as to the probability that the forecasting of the weather in Argentina will be materially improved by the aid of solar-radiation measurements. If this proves to be the case, it is greatly to be hoped that means will be found to increase the number of observing stations qualified to measure solar radiation. The station occupied in Chile lies on the Loa River, also on the railroad from Antofagasta to Bolivia, about 150 miles east of Antofagasta. The altitude is 7,500 feet and the conditions about the station are entirely desert conditions, except in so far as modified by irrigation from the Loa River. The station occupied is a disused mining property of the Chile Exploration Company, which very generously allows its use for the purpose of the solar work. Every effort is being made to

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secure favorable and livable conditions for the staff and for their work, and the results so far obtained seem to be very promising and to reflect great credit on the zeal and accuracy of the observers.

FIG. 31.—The Loa River near Calama.

FIG. 32.—Bank of the Loa River.

THE COLLINS-GARNER FRENCH CONGO EXPEDITION

In November, 1916, Mr. Alfred M. Collins of Philadelphia invited the Smithsonian Institution to participate in an expedition to the French Congo with the object of procuring a general collection of vertebrates and in particular a good representation of the great apes. Mr. Collins was to be chief of the expedition, while the gen-

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eral management was to be placed in the hands of Mr. R. L. Garner, well known by his previous studies of chimpanzees and gorillas in the same region. Mr. Robert Aschemeier, an assistant taxidermist on the Museum force, was detailed to accompany the party. It was decided that the expedition should be known as the "COLLINS-GARNER CONGO EXPEDITION, IN THE INTERESTS OF THE SMITHSONIAN INSTITUTION."

Mr. Aschemeier and Mr. Garner sailed from New York for Bordeaux about the middle of December, 1916, Mr. Collins then expecting to follow a few months later. War conditions, however, greatly delayed the arrival of the first members of the party in Africa and have entirely prevented Mr. Collins, now Major Collins, from joining them.

After many difficulties had been overcome, largely through the extreme courtesy of the Governor General at Brazzaville, the Lieutenant Governor, and the Administrateur des Colonies at Fernan Vaz, Mr. Garner and Mr. Aschemeier finally established permanent headquarters. The following passages from a letter from Mr. Garner to Dr. Hrdlička give an idea of their surroundings:

"FERNAN VAZ, July 7, 1918.

"Our domicile is located on the edge of a vast plain, traversed here and there by belts and spurs of forest. In those plots of bush live great numbers of chimpanzees, and for the first time in my long experience among them I have seen whole families of them out on the open plain. Frequently they cross the plain from one belt of bush to another, in some places a mile or so in width and not a tree or bush in that distance to shelter them from attack. They often come within 200 to 300 yards of my house and sometimes manifest deep interest in trying to find out what this new thing is, set up in their midst. I have seen as many as four or five different groups of them in the same day, and one of these contained 11 members. One very old man has come, on two occasions, within 100 yards of me and scrutinized me very closely, while his wife (as I took his companion to be) appeared to be very uneasy and suspicious. On several occasions I have seen the young ones romping and tumbling about on the grass, chasing and scuffling with each other, exactly as you see human children do. A school of them slept, a few nights ago, within less than 100 yards of my house, in a very small clump of bush, not more than a hectare in extent, on one side of which is Lake Fernan Vaz and all around the rest of it an open plain, with the quarters of

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my crewmen not more than 200 yards away on the opposite side from me and a native village in plain view 500 yards away at an angle of about 30° from the crewmen's village. I have never before seen so many chimpanzees as I find here and I have never seen them so indifferent to the presence of human beings. Even while I was building and had as many as 18 or 20 natives moving about the place those reckless apes would often cross the open plain in full view and with apparent composure.

"Mr. Aschemeier has collected well on to 2,000 specimens and nearly all of them he has killed with his own gun. Some of these specimens are exceedingly rare and valuable. When you recall the fact that he came as taxidermist of the expedition and not as *chasseur*, he was not expected to provide the specimens that he was to preserve.

"We have forwarded six consignments of specimens to the Museum and have a seventh well on the way; but we find great difficulty in getting the steamers to take them from Port Gentil (Cap Lopez), because they are all under direction of the French military authorities. Two of our last shipments were still at Port Gentil last month, where one of them has been lying since last January and all steamers declined to take it. Once both shipments were taken aboard the steamer and bill of lading signed when the captain changed his mind and sent the whole lot back on shore, with the accumulated charges of 40 francs for embarkation and debarkation.

"We have sent 12 or 13 specimens of buffalo, several specimens and species of antelope and two or three fine specimens of the "red river hog," besides a large collection of monkeys, representing six or seven species of both sexes and various ages. I think in all we have sent over 1,500 up to this time. Of course this includes birds, etc., not insects, and we have on hand a goodly number.

"Yesterday I bought a fine, fresh skin of a thing the natives call *anima*. It is something very much like the civet cat in its general appearance, but it is not of the ordinary type. I have never examined one, but I think they are more canine than feline and the natives regard them as such. At any rate, it is a fine specimen and I am taking great care to cure it in the best manner possible.

"I will call your attention to a singular fact about the monkeys and especially of the mangabeys of this region. There appears to be prevalent among them some kind of disease resembling cancer, and it is not at all unusual to see one with his nose eaten away or sometimes one side of his face, while otherwise he appears active and

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FIG. 33.—Skull of West African Buffalo collected by Robert Aschemeier.

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normal. An isolated case now and then might be attributed to accident or to violence; but these cases are so common as to lead to the belief that it is a disease and, so far as I have observed, it appears to be confined to this one species, with the exception of one case in which I noticed the *mustache* monkey affected by it."

Detailed work has been done in the neighborhood of this base, and several expeditions have been made away from it. Under date of September 1, 1918, Mr. Aschemeier gives the following list of the more important specimens collected: Birds, 671; small mammals, 758; monkeys, 79; gorillas, 2; chimpanzees, 8; buffalo, 14; antelope, 42; wild pig, 10.

FIG. 34.—Riding water buffaloes is the favorite pastime of Celebean children, especially small boys. During the hot part of the day the buffaloes spend most of their time in a pond or pool, with all but their heads submerged, paying little or no attention to the children that climb over them and dive from their backs.

War conditions have seriously interfered with the shipment of material to Washington. Of the lots that have been sent only three had arrived up to the end of January, 1919. These included a total of 805 specimens, all in good condition. Among the more interesting may be mentioned a gorilla, seven chimpanzees, 12 buffaloes, eight wild pigs and parts of an elephant.

EXPEDITION TO BORNEO AND CELEBES

In the report on explorations during 1916 (Smithsonian Misc. Coll., vol. 66, no. 17, pp. 29-35) an account was given of field-work

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in Celebes to the end of August, 1916. Mr. Raven was then preparing to leave Menado. He arrived at Parigi on August 27 and remained in the central part of the island until March, 1918. At this time he started to return to America, but conditions of travel were so unfavorable that he did not reach San Francisco until September 20. The results of this expedition, from the beginning of field-work in January, 1916, are of great importance to the Museum. The main

FIG. 35.—*Cranorrhinus cassidix*, the large hollow casqued hornbill of Celebes inhabits the whole island excepting the high mountains and is known to the natives by names such as "boeroeng tahoen," "alo," and "ngoh," the latter resembling somewhat the birds call-note.

collections include about 1,500 mammals, 2,800 birds, and an extensive series of ethnological specimens, all from regions not hitherto represented. The special value of this material from our point of view is its close relationship to the collections previously made by Dr. Abbott in the more western part of the Malay Archipelago and by Dr. Mearns and others in the Philippines.

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FIG. 36.—To obviate the danger of specimens molding while in transit from the collecting ground to the Museum, it was necessary to dry them in the hot sun for a short time before they were finally packed. A boy was always detailed to guard drying specimens against domestic animals such as pigs, fowls, goats, dogs and cats.

FIG. 37.—A primitive method of plowing. The rice fields overgrown with grass, since the last harvest, are flooded and plowed by driving a herd of water buffaloes around and around until the grass is completely trampled beneath the surface of the mud.

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FIG. 38.—In the high mountainous districts of Central Celebes are many prehistoric tombs and images of stone. This one is about five feet high and called by the natives Watoe Langko.

FIG. 39.—The Pig-Deer, or Babi-Rusa of Celebes and some of the adjacent islands to the east seems to prefer as its habitat the coastal regions.

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FIG. 40.—With a proficiency born of patient practice, the Celebean native, skilfully carves, with an apparently unwieldy large knife, the sheath and handle for his side weapon.

FIG. 41.—Squilla, a prawn, is hunted by the people of the coast of Celebes as an article of food. After locating the animal's burrow they try to drive it out by thrusting poles down into the passage ways to which there is but one outlet. To be sure not to cut the animal off from the entrance of his burrow the probing is begun several feet away.

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FIG. 42.—A rattan bridge over the Koro River, at Bokoe, Central Celebes.

The Koro, which is the largest river of Central Celebes, is bridged at several places by rattan hanging bridges more than two hundred feet long; this one has as its mainstay, five large rattans each about three centimeters in diameter. Other smaller rattans are arranged as a hand rail.

FIG. 43.—Madurese Prahus in the Straits of Madura, near Java. The curious sail is made from the fiber of the banana tree, loosely woven but nevertheless quite durable.

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MARINE BIOLOGICAL STUDIES IN CALIFORNIA

Under the auspices of the United States Bureau of Fisheries, Waldo L. Schmitt, of the Division of Marine Invertebrates, U. S. National Museum, spent the months of August, September, and October in California engaged in a study of the life history of the West Coast spiny lobster, *Panulirus interruptus* (Randall).

The greater part of the time, by courtesy of the Scripps Institution for Biological Research, was spent at their laboratories at La Jolla, examining their extensive plankton collections for the larval stages of the "lobster." Considerable material, chiefly of the younger stages, was obtained here, including many specimens of the post-embryonic stage, hatched by Mr. P. S. Barnhart, curator of the institution's museum, in one of their large aquarium tanks. And further, the assistance extended by the director, Dr. Ritter, enabled Mr. Schmitt to conduct a two-day dredging and tow-netting trip both outside and inside of the extensive kelp-beds lying between La Jolla and Point Loma.

An examination was also made of the collections of the University of California at Berkeley, Stanford University at Palo Alto, the University of Southern California at Los Angeles, Pomona College at Claremont, the Venice Marine Biological Station (of the University of Southern California) at Venice, the Laguna Marine Laboratory (of Pomona College) at Laguna Beach, and the Museum of the San Diego Natural History Society at San Diego, and some pertinent material obtained.

But by far the richest samples of spiny lobster larvæ were returned through the activities and generous co-operation of the California State Fish and Game Commission. These collections were secured by means of a small otter trawl with a spread of about 20 feet, operated from their patrol-boat, the "Albacore," and contained many phyllosomes of large size as well as a number of pueruli. The latter represent the stage intermediate between the phyllosome, the form in which the "lobster" is hatched from the egg, and the definitive form of the adult.

An interesting feature brought out by the collections made by the State Fish and Game Commission was the great off-shore range of the phyllosomes and the depth at which some of them were obtained—as much as 150 miles off shore, and to a maximum depth of 75 fathoms. A phyllosome taken at that depth, some 16 miles off Los Coronados Islands, is shown in figure 44.

Certain incidental shore and tidepool collections were made while at La Jolla.

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FIG. 44.—Large phyllosome of the California spiny lobster, *Panulirus interruptus* (Randall).

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BOTANICAL EXPLORATION IN ECUADOR

During the year a plan for a co-operative investigation of the flora of northern South America was organized by the United States National Museum, the New York Botanical Garden, and the Gray Herbarium of Harvard University. It is believed that this investigation will greatly enrich our botanical collections and furnish information regarding economic plants which will be of much value to the horticultural and agricultural interests of this country.

FIG. 45.—A view in the upper valley of the Chanchan River. The mountain mass in the center is called the Devil's Nose. Photograph by George Rose.

The first field expedition under this co-operative plan was undertaken by Dr. J. N. Rose, associate curator in the United States National Museum. He was also materially aided by the Bureau of Plant Industry of the United States Department of Agriculture. Dr. Rose, accompanied by George Rose, left Washington July 22, and returned December 4, 1918. In addition to his visit to Ecuador he made short stops at Cuba, Panama, and Haiti, collecting a few plants at each place.

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FIG. 46.—A view of Chimborazo, taken at an altitude of about 12,000 feet. Photograph by George Rose.

FIG. 47.—A view of the Chanchan Valley looking west from Huigra. Photograph by George Rose.

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Three months were devoted to work in Ecuador and very large collections were made, including about 6,000 botanical specimens, 100 jars of fruits, seeds, and plant products preserved in formalin. Several hundred packets of seeds, a number of wood specimens,

FIG. 48.—Giant cactus plant, apparently undescribed, which is very common in the Chanchan Valley. Photograph by George Rose.

samples of cinchona-bark and small collections of fishes, frogs, shells, and other zoological material were obtained. George Rose, who went as photographer, made about 260 negatives of landscapes and plant subjects.

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FIG. 49.—A species of Furcraea from which is obtained one of the most useful fibers in Ecuador. It is called caboya. Photograph by George Rose.

FIG. 50.—Residence of the general-manager of the Guayaquil and Quito Railway Company at Huigra. Photograph by George Rose.

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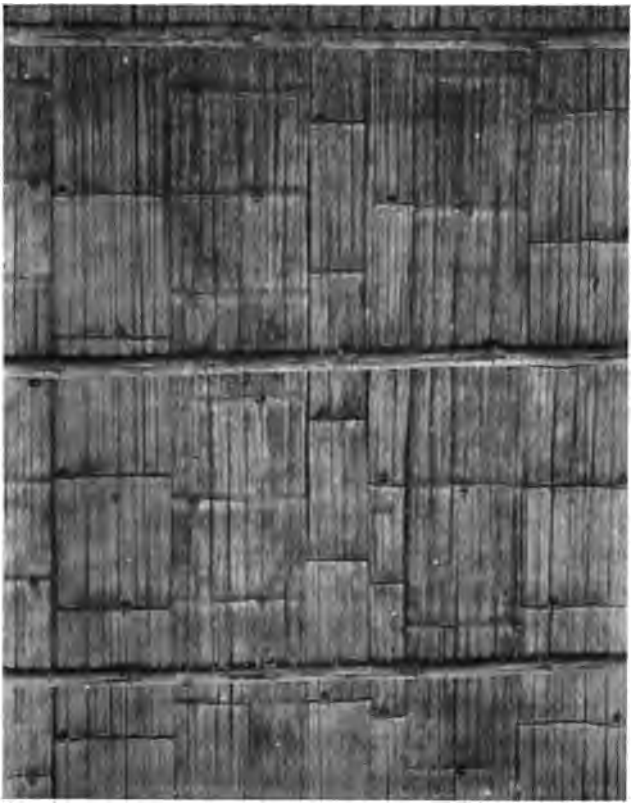

FIG. 51.—Detail of bamboo boards. This giant bamboo is much used in the construction of houses and fences in the low country along the coast of Ecuador. Photograph by George Rose.

FIG. 52.—A view of the Quinta Normal at Ambato, the first Agricultural Experiment Station to be established in Ecuador. Augusto N. Martinez is director. Abelardo Pachano, Professor of Agronomy, was educated at Cornell University. Photograph by George Rose.

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FIG. 53.—American Hospital at Portovelo. This hospital belongs to the South American Development Company and is in charge of an American doctor. Much is being done here to relieve the condition of the poor in southern Ecuador. Photograph by George Rose.

FIG. 54.—Market view. The bowl contains wild blueberries (*Vaccinium mortinia*). Photograph by George Rose.

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FIG. 55.—Types of Cañar Indians. Photograph by George Rose.

FIG. 56.—Market view, showing the ocha (*Oxalis tuberosa*) a well-known root crop of the high Andes. Photograph by George Rose.

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Two sections were made from the coast across the western range of the Andes to the interior Andean Valley; one in the south from Santa Rosa to Loja and the other near the center of the country from Guayaquil to Riobamba. A longitudinal section was made down the Andean Valley from San Antonio to Loja. This last section was over the route followed by Alexander von Humboldt at the beginning of the eighteenth century. Many of the plants collected by him on this memorable journey were recollected.

Figures 45 to 56 show the nature of the country, some unusual types of vegetation, the class of buildings, market scenes, and native inhabitants.

BOTANICAL FIELD-WORK IN THE SOUTHWESTERN UNITED STATES

During the month of August, 1918, Mr. A. S. Hitchcock, systematic agrostologist of the Department of Agriculture and custodian of the section of grasses of the Division of Plants in the U. S. National Museum, visited Arkansas, Oklahoma, Texas, and Colorado for the purpose of studying the grasses. In Arkansas, Oklahoma, and eastern Texas the season was unusually dry and hot. As the grasses were in an unfavorable condition for study little time was spent in these states. Collections were made at Fayetteville and Pine Bluff in Arkansas, Stillwater in Oklahoma, and Fort Worth in northeastern Texas. At Amarillo in northwestern Texas the season was more favorable and the grasses were in good condition for study.

Amarillo is situated in the midst of a plain and the flora is characteristic of much of the Great Plains region of the western parts of Texas and Kansas, and of the eastern parts of New Mexico and Colorado. Grasses form the dominant vegetation, and the collection here represented 30 species. Buffalo grass (*Bulbilis dactyloides*) forms patches of sod, but most of the species are bunch grasses and do not form a continuous covering to the soil. The most common are the grama grasses (*Bouteloua hirsuta* and *B. gracilis*) and the needle grasses (*Aristida longiseta, A. purpurea,* and *A. wrightii*). An interesting species (*Eragrostis barrelieri*) was found here in small quantity, evidently being a newcomer. The species is a native of southern Europe and appeared a few years ago in southern Texas, the first collection being made in 1894 by A. A. Heller at Kerrville. In 1897 J. G. Smith collected it at the same place and also at Llano.

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In 1902 Professor Tracy found it at Abilene. In 1910 the writer collected the species in several localities (Big Spring, Kerrville, Brownsville, San Antonio, Kenedy) and observed it to be a common weed in lawns and along streets. In time the species will probably spread over a much wider area.

Several days were spent in the vicinity of Long's Peak, Colorado, the headquarters being Long's Peak Inn. This is reached by rail from Denver through Boulder to Ward and by stage northward to Estes Park, Long's Peak Inn being one of several hotels in the park. The hotel is at an altitude of about 9,000 feet. To the east are two peaks, the Twin Sisters, rising to a height of about 11,500 feet. Long's Peak lies a little south of west, in an air line about four and

FIG. 57.—A view of Long's Peak from the summit of Twin Sisters. Long's Peak is the central dome, the summit of which is 14,255 feet. Chasm Lake lies at the base of the cliff below the snow bank.

one-half miles, its summit reaching an altitude of 14,255 feet, over 100 feet higher than Pike's Peak, the best known of Colorado's mountains. A short distance to the northwest is Estes Cone, a symmetrical, isolated peak about 11,000 feet high.

One trip was made to the summit of Twin Sisters and another to the summit of Long's Peak. The second trip was made in company with Titus Ulke and Mr. Babcock, the latter a forest ranger kindly placed at our service by the superintendent of the park. Mr. Babcock had ascended the peak many times, having acted as a guide to tourists. His efficient aid was greatly appreciated.

The party set out in the morning for Timber Line Cabin (11,000 feet) and spent the afternoon in observations at Chasm Lake and

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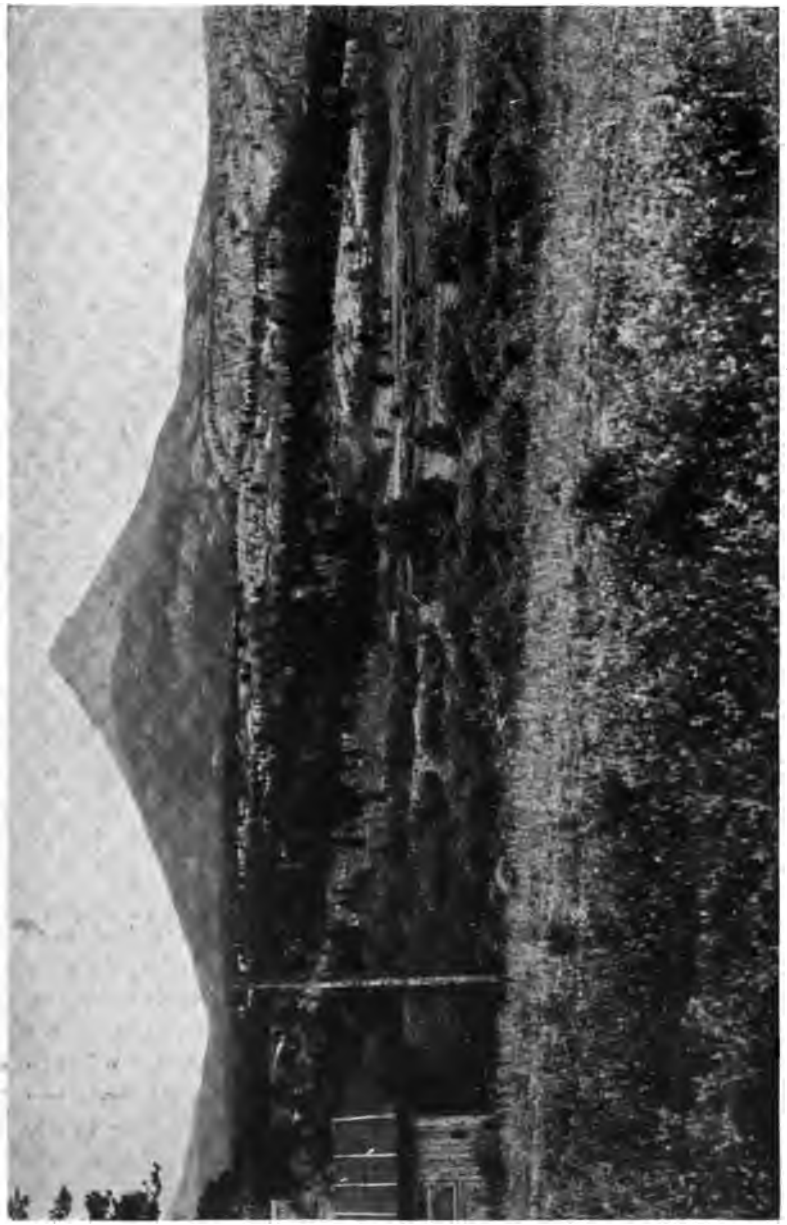

FIG. 58.—Estes Cone as seen from Long's Peak Inn. This regular peak is about 11,000 feet high. The shrubs in the foreground are alders along a stream; the conical trees are Engelmann spruce; the more irregular dark trees are lodgepole pine.

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FIG. 59.—The summit of Long's Peak from Chasm Lake. A part of the lake is shown at the lower right-hand corner. The rounded dome in the center is the summit. The precipice is about 2,000 feet high.

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vicinity. Chasm Lake lies at the foot of the east face of Long's Peak, which rises above it, a sheer precipice of over 2,000 feet. A beautiful and well-marked lateral moraine leads away to the east of the lake. On the morning of the second day the ascent of the peak was commenced and the summit was reached about noon. Fortunately the weather was clear and the whole surrounding country lay in plain view for many miles, even Pike's Peak being distinguishable, nearly 100 miles to the south.

The timber-line is at approximately 11,000 feet. In this vicinity the trees are stunted by the force of the winds and can develop only

FIG. 60.—A heavy rock near Chasm Lake, probably transported by glacial action and left supported by four small stones.

in the lee of rocks and hillocks. It is not uncommon to find a dense growth of pine or spruce reaching up to the level of a protecting ledge, but prevented by the force of the wind from extending above this level.

The forest on the slopes of the mountain consists mainly of four species, the aspen, the Englemann spruce, and two kinds of pine. The aspen (*Populus tremuloides*) is a deciduous tree with smooth light green or nearly white bark, found up to about 10,000 feet. The Engelmann spruce (*Picea engelmanni*), a beautiful conifer with a tapering top, is common over all the upper stretches of the mountains. The lodgepole pine (*Pinus contorta*) is the common pine

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FIG. 61.—Engelmann spruce (*Picea engelmanni*), a beautiful pyramidal tree, forming the bulk of the forest in this region.

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around Long's Peak Inn and the lower slopes of the mountains. At the higher altitudes the limber pine (*Pinus flexilis*) is frequent. This species is recognized by its very elastic "limber" branchlets which bend without breaking.

The herbaceous plants with showy flowers, the real "flowers" of the tourist, are abundant and attractive. One of the most conspicuous plants is the green gentian (*Frasera speciosa*), not so much for the flowers as for its stately appearance. It grows to the height of 2 to 4 feet, a single erect stem with numerous leaves and masses of green flowers from their axils. There are several

FIG. 62.—A young growth of lodgepole pine (*Pinus contorta*), the common pine of Estes Park. Altitude 9,000 feet. One peak of Twin Sisters rising at the right.

species of gentian, some rare, some abundant, all much sought by tourists. The lupine (*Lupinus decumbens*), with racemes of blue flowers, the harebell (*Campanula rotundifolia*), with delicate stems and large blue bell-shaped flowers, and several species of daisies (*Erigeron*) are among the more showy of the late summer flowers.

Above timber-line are the alpine meadows, boggy areas supporting a growth of grasses and sedges with other plants intermixed. There are no trees, but shrubs extend upward in the protected valleys or depressions. The pine and spruce are found in the form of "krumholz," stunted growths in the lee of rocks, as described in a preceding

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FIG. 63.—A single tree of lodgepole pine (*Pinus contorta*), aspens in the background.

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FIG. 64.—A stunted pine (*Pinus flexilis*) near Timber Line Cabin. The tree, now many years old, is sheltered from the severe winds behind a rock, but above the level of this it cannot extend. A stunted growth of this kind is known to the ecologist as krumholz.

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FIG. 65.—Down timber, the bane of the explorer. This is the result of high winds and forms an intricate mass of interwoven trunks very discouraging to the naturalist who may depart from the trail.

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paragraph. Two species of alpine shrubs are common, mountain birch (*Betula glandulosa*) and a small willow (*Salix brachycarpa*). These last two form extensive areas of dense low growth, in many of the depressions from 10,000 to 12,000 feet. A common plant of the alpine meadows is the bistort (*Bistorta bistortoides*), with oval heads of white flowers. Probably the most beautiful of the mountain flowers is the columbine (*Aquilegia coerulea*), with large blue

FIG. 66.—The columbine (*Aquilegia coerulea*), one of Colorado's most beautiful wild flowers. The large flowers are blue or lavender. The state flower of Colorado.

flowers, which is found through a wide altitudinal range, in the forested zone, and on the alpine slopes to 12,000 feet.

The chief object of the visit to Long's Peak was the study of the grasses, especially the species growing above timber-line. It is only by a study of the species of mountain bluegrasses (*Poa*) *in situ*, that one can determine whether the different forms belong to a single variable species or represent distinct species. Twenty-one species of grasses were obtained, the common or well-known species not being collected.

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FIG. 67.—Green gentian (*Frasera speciosa*), a stately plant about four feet high. Common from 7,000 to 10,000 feet.

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ANTHROPOLOGICAL SURVEY OF THE SOUTHWESTERN COAST OF FLORIDA

In November, 1918, Dr. Aleš Hrdlička supplemented his former work in Florida by a four weeks' exploration of the little known region of the Ten Thousand Islands. The objects of this journey, which was carried out under the auspices of the Bureau of American Ethnology, were to trace the anthropological type of the former aboriginal population along this unknown remainder of the western coast of the peninsula, and to study such Seminole Indians as could be found roaming among the islands.

The results will be published more fully later. They are briefly as follows: The region of the coast south of Key Marco, which was

FIG. 68.—The Mangrove Swamps.

supposed to be of no great account as far as aboriginal remains were concerned, was found to be full of sites, shell heaps, platforms, and mounds, with canals and other evidences of former Indian occupation, the remains covering in individual instances 20, 30, and even 80 acres of ground. Only the southernmost parts of the coast are poor in such remains. And all of this is still intact so far as scientific exploration is concerned.

It was determined that these remains are throughout of the same class, though differing in very interesting details, and the conclusion seems justified that they represent the same culture and people, identifiable with those farther north, up to and beyond Charlotte Harbor. A part of these people were known historically as the Caloosas, and have left their name in that of the Caloosahachee

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FIG. 69.—A Mound in the Jungle, Florida.

FIG. 70.—Shell Heaps, Allen River, Florida.

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River. They were, according to such evidence as we possess (crania, etc.), a homogeneous stock, physically related to the type of the eastern Algonquins. The round-headed people of farther up the coast and the St. John's River were evidently wholly absent in this region.

Of the Seminoles, four individuals were met with among the islands, of whom two were full-bloods. One of these latter submitted to measurements. These Indians roam over most of the Everglade

FIG. 71.—A Seminole Hut, Florida.

part of southern Florida as well as among the myriad of keys off the coast. They are partly "civilized," but prefer to be left alone. They are considerably mixed with whites and slightly also with negroes, but this mixture does not seem to be recent. They have few if any steady all-the-year-around habitations and lead a more or less nomadic life, moving from place to place in quest of food or for other reasons. They can be met with occasionally, individually or in parties, from Palm Beach on the east coast to Fort Myers on the west, and from Lake Okechobee to the southern extremity of the peninsula.

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FIG. 72.—Seminoles in Boats.

FIG. 73.—Seminole Types.

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ANTHROPOLOGICAL WORK IN PERU AND BOLIVIA

In October, 1917, Mr. Philip Ainsworth Means, honorary collaborator in American archeology, U. S. National Museum, reached Peru to do archeological work. A short time was first spent in the vicinity of Lima, during which were studied several ruins about the capital, under guidance of Drs. José de la Riva-Aguero and Julio C. Tello. Two of the least known places visited were Maranga and Pando. They are very close together and are about 6 miles northwest of Lima. In its prime, Maranga (see fig. 76) had four fine terraces with a spacious terreplein at the top. At the bottom, the pyramid is

FIG. 74.—The raised end of the chief room in the small palace at Pando. Note the attractive arabesque patterns in the stucco which covers the walls.

about 450 feet square and the summit terreplein is about 250 feet by 350. The material of construction is adobe. This pyramid is probably of Inca construction; it is much like the Inca built Temple of the Sun at Pachacamac and has yielded many Inca artifacts.

Lying somewhat north and northwest of Maranga are the ruins of Pando. These cover an immense amount of ground and consist of several pyramids even larger than Maranga, but not so well preserved. The old city at this place was enclosed in a massive wall with easily defended gateways. These latter were narrow, and, at either side, sunk in the thickness of the wall there was a raised platform or niche where possibly a guard could stand and effectually oppose ingress.

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At the western side of Pando there are the remains of a fine though small palace or temple. Although it is only about 85 feet square, this little building is remarkable on account of the attractive arabesque patterns made in the stucco coating of the walls. (See fig. 74.) The western end of the main room was provided with a platform raised some 3 feet above the rest of the floor. Behind this there was a passage (fig. 75) which led to other apartments. It is not now possible to know exactly what sort of roof there was, for the wind has eroded the tops of the walls and signs of roof beams or joists are no longer visible. The present inhabitants of this

FIG. 75.—Corridor of the small palace at Pando. A dwelling of present inhabitants in the background of the picture.

ruin are a wretched Indian family who live in the crude shelter made of burlap and old gasoline cans seen in figure 75.

From Lima Mr. Means went to Arequipa and La Paz and while at the latter place he visited Tiahuanaco. There are, besides, several related sites in the region, notably Pumapuncu Llojepaya and Viacha, which are almost unknown. The chief collections studied at La Paz were those of Messrs. Federico Diaz de Medina, Agustín de Rada, Arturo Posnansky, and that of the Museo Nacional (directed by Sr. Jáuregui.)

From Bolivia, Mr. Means went to Piura in northern Peru. There he hoped to find much archeological material, but various sorts of grave plunderers had preceded him, and archeological sites are apparently few. The collections of Dr. Victor Eguiguren (of Piura) and of D. Luis Elias y Elias (of Morropón) were examined.

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On returning to Lima, Mr. Means made other trips to various sites in that neighborhood, which is undoubtedly still one of the richest in South America, from the archeological standpoint. He also examined the collections owned by Drs. Javier Prado y Ugarteche and Julio C. Tello.

FIG. 76.—The pyramid or *huaca* of Maranga about six miles northeast of Lima. The view was taken from the northwest of the pyramid.

ARCHEOLOGICAL FIELD-WORK IN SOUTHWESTERN COLORADO AND UTAH

The chief of the Bureau of American Ethnology, Dr. J. Walter Fewkes, spent a month in field-work in southwestern Colorado and the adjoining State, Utah, directing his attention to the structure of the remarkable towers and castles to which attention was called in an account of his work last season. The purpose of this visit was to enlarge our knowledge of the forms and characteristics of these buildings and their relation to similar structures on the Mesa Verde National Park.

One of the important results of the field-work of 1918 was the discovery of two hitherto unknown towers in McLean Basin, near Ruin Canyon, about 35 miles from Dolores, Colorado. The exceptional feature of these towers is their situation on the diagonal corners of a rectangular ruin. One of these towers (fig. 78) is circular, the other (fig. 79) **D**-shaped; both are constructed of good masonry and stand about 15 feet high. Their relation to the fallen

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FIG. 77.—Circular and D-Shaped Towers in McLean Basin Ruin. Photograph by J. Walter Fewkes.

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walls of the remainder of the ruin is shown in the view of a model (fig. 80).

Dr. Fewkes likewise examined three towers in Mancos Canyon, one of which (fig. 81), called Holmes Tower from its discoverer, has been known for 40 years. This tower has the same general form as those on the Mesa Verde.

FIG. 78.—Circular tower, McLean Basin, Utah. Photograph by T. G. Lemmon.

The additional data collected during the past season indicate that the towers and great houses of the McElmo region may have served, among other purposes, as granaries for storage of food. All have certain features in common with Sun Temple, on the Mesa Verde, although architecturally they are much simpler. A tower in Sand Canyon (fig. 82) resembles those in the McElmo Canyon.

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Sand Canyon, one of the northern tributaries of the McElmo, contains several prehistoric buildings which have not hitherto been described, but offer possibilities for future research. Among these are well-made cliff-houses, one of the best preserved of which is shown in figure 83. There is another house (fig. 84) in a ceremonial cave, consisting of a single circular kiva of the Mesa Verde type

FIG. 79.—D-shaped tower, McLean Basin, Utah. Photograph by J. Walter Fewkes.

surrounded by rectangular rooms, occupying the whole floor of the cavern. This building is a unique example of a pueblo of the single unit type situated in a cave. A remarkable feature is the existence of walls of a more modern kiva built inside those of an older chamber, resembling in this respect one of the kivas of Spruce Tree House, on the Mesa Verde National Park. Another unusual ruin in Sand

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FIG. 80.—Model of Towers in McLean Basin, Utah.

FIG. 81.—Holmes Tower, Mancos Canyon, Colorado.
Photograph by T. G. Lemmon.

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Canyon is a wooden scaffold in a cave like that of Scaffold House in the Navajo National Monument.

There are several other cliff-houses in Sand Canyon all of which resemble in the structural features of their kivas those of Mesa Verde and Chelly Canyon, but differ from those of the Upper Gila and Salt rivers.

The group called cliff-dwellings, from the fact that they occur in caves or cliffs, was formerly universally recognized as a division in

FIG. 82.—Sand Canyon Tower, Colorado. Photograph by T. G. Lemmon.

a classification of southwestern ruins. It is evident from enlarged knowledge of the architectural forms of these buildings that the only difference between the so-called cliff-dwellings and others found in the open is their site; structurally they are identical and were evidently constructed by the same people. Some cliff-dwellers were related to the Pueblos, but all cliff-dwellings were not built by people

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FIG. 83.—Cliff dwelling, Sand Canyon, Colorado. Photograph by T. G. Lemmon.

FIG. 84.—Ceremonial cave, Sand Canyon, Colorado. Photograph by T. G. Lemmon.

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FIG. 85.—Fish Creek Canyon, Apache Trail, Arizona. Photograph by Mark Daniels.

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FIG. 86.—Cliff dwelling, Pueblo Canyon, Sierra Ancha, Apache Trail, Arizona. Photograph by Mark Daniels.

FIG. 87.—Cliff dwelling, Cherry Creek, Sierra Ancha, Apache Trail, Arizona. Photograph by Mark Daniels.

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of exactly the same mode of life as Pueblos. For instance, the cliff-dwellings of the Verde Valley, a tributary of the Salt River in southern Arizona, are different structurally from those of the San Juan Basin in Colorado and Utah. Some of these aberrant cliff-houses, thus far little known, but pleading for investigation, are situated in Tonto Basin near the Apache trail, Arizona. The character of the environment in this region appears in the view up Fish Creek (fig. 85), a rugged canyon, the mouth of which is visible to travelers on the road to Roosevelt Dam.

FIG. 88.—Interior cliff dwelling, Cherry Creek, Sierra Ancha, Apache Trail, Arizona. Photograph by Mark Daniels.

By courtesy of Mr. Mark Daniels, photographs showing cliff-dwellings of the Sierra Ancha Mountains in southern Arizona are here reproduced (figs. 86 to 87). Although these buildings are situated in cliffs they have only a distant likeness structurally to those of the Mesa Verde National Park in southwestern Colorado. The principal difference from the latter is the absence of circular ceremonial rooms or kivas. They may be said to represent the cliff-dwelling phase of a house building culture that reached its highest development in so-called compounds near the Gila which are unlike

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pueblos. They are villages typical of the plains of southern Arizona built in caves of a mountain environment. Their masonry is comparatively poor, with a tendency to the horizontal, but has component stones arranged in irregular courses, the mason relying more on natural cleavage than artificial pecking or dressing. Plastering still remains on the outer surfaces in several cases. In one of these the roof is in place and well preserved, as shown in figure 88. A remarkable pictograph from this region is shown in figure 89.

FIG. 89.—Indian inscriptions, Cherry Creek, Sierra Ancha, Apache Trail, Arizona. Photograph by Mark Daniels.

Among many instructive sites of ruins in the Hovenweep district is the bluff where the Yellow Jacket Canyon enters the McElmo. On top of this high promontory there are enclosures built of megaliths set on edge, apparently of the same cyclopean type of construction that characterizes larger buildings described by Jackson on Montezuma Mesa, Utah. We are evidently here on the dividing line, geographically, between the region of stone slab houses and the horizontal masonry of the Pueblo culture, such as is found on the McElmo. They are believed to represent an archaic masonry older than the kiva type of Mesa Verde.

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It was found that the artificial heaps of stones in the Montezuma Valley and the mesa north of the McElmo are arranged in clusters forming villages like the Mummy Lake Group on the Mesa Verde. All component mounds of a group are the remains of buildings constructed on the same general plan, their size depending on the number of component unit types or kivas. The characteristic form of a unit type with four kivas is shown in Far View House, illustrated in the account of field-work for 1916. There is every reason to suppose that a like clustering of small pueblos into villages occurs on the Mesa Verde, throughout Montezuma Valley, and on the summits of the mesa north of the McElmo.

FIG. 90.—Mound on Santa Fé Ranch, near Topila, Vera Cruz. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

Chronologically arranged, the classification of ancient habitations in the McElmo, adopted as a result of recent field-work, is as follows: (1) Single houses with walls constructed of rude cyclopean masonry, stone slabs or megaliths set on end. (2) Villages in cliffs or in the open, composed of units of the same structure in clusters or consolidated, each unit being composed of a characteristic circular kiva with vaulted roof embedded in rectangular rooms. Towers and great houses, either isolated or united, are sometimes found in this group, which is a prehistoric type, now extinct, the highest attained by the Pueblos. (3) The mixed type of architecture, found in modern pueblos, has no embedded circular kivas, and marks an epoch of decline in house building largely due to admixture or influence of other tribes.

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Aztec Spring Ruin in the Montezuma Valley will probably, in the future, become of considerable popular interest, as the owner, Mr. Van Kleeck, of Denver, has generously offered the site to the Public Parks Service for permanent care by the United States Gov-

FIG. 91.—Side view of painted clay drinking vessel with hollow handle. Tempoal, Vera Cruz. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

ernment. In order to be in a position to give expert advice on the desirability of accepting this generous offer, Dr. Fewkes revisited Aztec Spring Ruin and reports that it is not only one of the largest and most typical prehistoric villages of the Montezuma Valley, but also recommends that it be excavated and repaired.

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ANTIQUITIES OF THE GULF COAST OF MEXICO

Several years ago (1904-1905) Dr. Fewkes made a preliminary trip to the Mexican states, Vera Cruz and Tamaulipas, for the purpose of tracing the relationship of the Totonac and Huaxtec Indians along the Gulf coast to the mound builders in the United States, or

FIG. 92.—Front view of painted clay drinking vessel with hollow handle. Tempoal, Vera Cruz. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

across the Gulf of Mexico to the prehistoric inhabitants of Porto Rico and Cuba or other adjacent Antilles. A fair beginning was then made in this direction and the results were published in the Twenty-fifth Annual Report of the Bureau of American Ethnology. He has again taken up the problem, and through the kindness of friends has collected additional data bearing on these questions.

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FIG. 93.—Clay heads, Tampico, Mexico, U. S. National Museum. The two outer heads in the middle row are from San Juan Teotihuacan, Valley of Mexico. Photograph by De Lancey Gill.

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The general appearance of ruined buildings or mounds, locally called "cuves" (fig. 90), situated along the Panuco River, Mexico, recalls that of Louisiana mounds, but unlike them, as a rule, they were faced with stone work, absent in all the mounds of the Mississippi Valley. On top of the Mexican mounds there stood a stone superstructure or temple, but the mounds show no indication of walls within, as is the case with artificial stone heaps in Colorado,

FIG. 94.—Stone slab from the Cerro Cebadilla, U. S. National Museum. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

Utah, Arizona, and New Mexico. These remains and pottery objects (figs. 91, 92) found near them are ascribed to the ancient Huaxtec Indians.

The figurines (fig. 93) made of burnt clay that have been exhumed from these mounds recall in a distant way the clay heads found in the Antilles, but more closely resemble those of the mainland. The ancient pottery of the inhabitants of the valley of the Panuco is allied

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FIG. 95.—Stone Idol, Panuco, U. S. National Museum. Photograph by De Lancey Gill.

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FIG. 96.—Stone Idol, Tampico, U. S. National Museum. Photograph by De Lancey Gill.

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to the archaic ware of the Valley of Mexico. Burnt-clay heads from the Huaxtec region distinctly resemble archaic heads from the Valley of Mexico, two of which, from San Juan Teotihuacan, are here figured (fig. 93).

A flat stone slab (fig. 94) from Cerro de Cebadilla in the Panuco region, now in the U. S. National Museum, was part of the facing of one of these cuves, or possibly one of the bounding stones of a ball court used by the Huaxtecs, and recalls prehistoric Porto Rican remains called *juegos de bola*. The stone idols from the Huaxtec

FIG. 97.—Stone Idol, Jopoy, Tamaulipas, U. S. National Museum. Photograph by De Lancey Gill.

region are characteristic, as seen in the hitherto undescribed specimens (figs. 95, 96, 97). The representation of a conical hat found on one specimen (fig. 98) would seem to indicate the same god as that figured and identified by Sahagun as Quetzalcoatl, the Plumed Serpent. The art shown by figure 100 recalls that on stone collars and three-pointed stones, but the enigmatical objects from Haiti and Porto Rico are not found in North, Central, or South America. Possibly the stone collars of the Antilles may be idols embodying the insular conception of a being corresponding to the Bird Snake Dragon of the Mayas.

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FIG. 98.—Idol with pointed cap, Panuco, U. S. National Museum. Photograph by Delancey Gill.

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One of the figures (fig. 99) shows a circular stone object from a Huaxtec ruin near Topila on which is depicted a cross used in "patolli," a favorite game among the Mexicans.

One of the most striking of the stone images from this region is owned in Guerrero, San Luis Potosi, by General Larraga, and was found in Consuelo. The remarkable thing about this idol is the imitation of tattooing on the body, right leg, and wrists (fig. 101). On the back is a representation of a human figure, the head of which is in high relief.

FIG. 99.—Stone slab at Mata de Palanchó, near Topila, Vera Cruz, Mexico. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

We have thus far little information on the antiquities of the region that lies between the most northern of the Huaxtec ruins and Louisiana across the Mexican state of Tamaulipas, and Texas. The modern Huaxtecs speak a language that shows relation to the Maya stock, but they never attained a high degree of architecture nor developed a complicated hieroglyphic calendar system comparable with that of their southern relatives. None of the prehistoric objects from other localities on the Gulf coast of Mexico are more closely related to those of the Greater Antilles than the stone and ceramic specimens of the Huaxtec, but the prehistoric culture of Porto Rico-Haiti was indigenous and characteristic.

Through the courtesy of Mr. J. M. Muir, Dr. H. Adrian, and Dr. Staub, who have generously furnished him with photographs,

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FIG. 100.—Stone idol, Tampico, U. S. National Museum. Photograph by De Lancey Gill.

Left side Right side Back

FIG. 101.—Stone idol with incised decorations from Consuelo, San Luis Potosi. Courtesy of Drs. Adrian, Staub, and Mr. Muir.

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notes and maps, Dr. Fewkes has in preparation an extensive memoir on the antiquities of the oil fields of Mexico, which will supplement and in some respects enlarge our knowledge of the archeology of that region.

ARCHEOLOGICAL EXPLORATION IN ARIZONA

The exploration in Arizona under the auspices of the bureau, by Dr. Walter Hough, curator of the Division of Ethnology, U. S. National Museum, was productive of interesting observations on

FIG. 102.—Cliff House, Oak Creek (White Mt., Apache Reserve).

prehistoric ruins, many of which are undescribed. Owing to the scarcity of labor on account of the draft the exploration was confined to a reconnoissance of the ruins in the vast region lying west of Fort Apache and including the Tonto Basin Forest. The work covered a portion of this area and required 500 miles of travel by various means of locomotion. Much of the country traversed is very difficult, being broken by deep canyons eroded in the slopes of the great Mogollon escarpment, known locally as the "rim" or "mountain," a tremendous geographic feature of dominant importance, in which the rivers of southern Arizona take their rise.

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FIG. 103.—White Mountain Apache House.

FIG. 104.—Great Kiva, near Fort Apache, Arizona.

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At intervals along the trail through this country of majestic picturesqueness are ancient ruins of considerable size and hidden in the canyon walls are cliff-houses (fig. 102), showing that in ancient times the environment furnished sustenance for an aboriginal population. Entering Tonto Basin the landscape assumes a wilder aspect, the region becoming drier and exhibiting a great variety of cacti and thorny growths among bristling rocks. North of the Sierra Ancha the country opens out into park-like stretches, in which the towns

FIG. 105.—White Mountain Apache, Oak Creek, Arizona.

of Young and Payson are located. As the character of the geography changes gradually from Fort Apache to Payson in the Tonto, it is seen that the ruins represent a gradual diminution of culture, those of the northern Tonto Basin being ruder in art than those to the east. The latter are generally of large compact pueblos, the art affiliations of which, judging from the pottery, are with those of the north in the basin of the Little Colorado, but plainly showing a rather high development. As the exploration proceeded west it was found that coincidences of southern culture appeared, while in the northern portion of the Tonto Basin the culture appears to affiliate entirely with the lower Gila and west of that river.

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The art of the cliff-houses does not appear to correspond with that of the neighboring open-air pueblos so far as pottery and some other things are concerned. It is probable that the cliff-house sites in this region represent the habitations of a small house people. It is also possible that there were spread over the Pueblo region tribes that never formed the habit of coalescing into compact pueblos. Much that has been discovered substantiates this theory.

A rather unusual evidence of the age of a pueblo was furnished by a juniper 126 inches in circumference growing in the house mass of a ruin near Blue House Mountain in the western portion of the Apache Reservation.

Near Fort Apache a ruin was observed which had as a prominent feature a rectangular depression 45 by 51 feet square and at present 5 feet deep and occupied by three large pine trees (fig. 104). This great construction is believed to be a kiva and is evidently like those described on the Blue River and Upper San Francisco at Luna, New Mexico.

In connection with the Apache Indians with whom Dr. Hough was thrown in contact during this exploration, it may be said that notable changes have taken place among them since 1901, when he visited them. There is little except their habitations (fig. 103) to connect them with their former life, all traces of native costume, etc., having disappeared. The Apaches are on the whole prosperous and contented and have an intelligent appreciation of their duties to the United States (fig. 104).

ARCHEOLOGICAL RECONNOISSANCE OF NORTHWESTERN ARIZONA

Late in April, 1918, provision was made by the Bureau of American Ethnology for a brief archeologic reconnoissance of that little known section of Arizona lying north of the Colorado River, and Mr. Neil M. Judd, of U. S. National Museum, was detailed for the purpose.

From Kanab, Utah, Mr. Judd proceeded with pack mules on a route lying southeastward over the northern portion of the Kaibab National Forest to House Rock Valley, thence southward across North, South, and Saddle canyons to the Walhalla Plateau, known locally as "Greenland." He examined a large number of low mounds bordering the rim of this promontory or scattered over its timbered ridges.

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House remains were plentiful along the road and the narrow trails. They began with those previously noted in Johnson Run[1] and included the small exposed ruins near Cape Royal and Cape Final, overlooking the Grand Canyon. The remains are those, usually, of one-, two-, or three-room structures; their walls are of irregular and entirely unworked blocks of limestone, sandstone, or chert, depending upon the character of the material nearest the site occupied. Such blocks were picked up by the ancients from the surface of the ground and apparently were laid in large quantities

FIG. 106.—Open ruin on the brow of a low hill about 7 miles south of the new corrals, House Rock Valley.

of mud; numerous small fragments were added as a support for the mortar and as a partial protection against the action of the elements. The small number of sizable building stones on some sites, in proportion to the quantities of lesser pieces, suggests that certain houses may have been constructed chiefly of mud, although real adobe is not to be found in the region. In several of these it is obvious that the walls included but one or two courses of rock—there are no remaining traces of others. In many instances the stones at the bottom of the wall were placed on edge, their upper, unworked surfaces probably supporting rough masonry or rubble.

Potsherds collected near the ruins indicate that the development of the ceramic art among these ancient people was not far behind that

[1] Smithsonian Misc. Coll., vol. 66, No. 3, p. 70.

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of the prehistoric Pueblos of the San Juan drainage and neighboring sections of the southwest. Shards ornamented with black geometric designs seem to predominate, but there are also numerous fragments of black-on-red and the customary plain and corrugated ware. Those which are decorated exhibit no marked variations from shards of similar design found upon ruins in better known localities and tend to substantiate the belief that a definite cultural relationship existed between the prehistoric peoples on either side of the Colorado River.

A small group of ruins distinctly different in type from those observed on the Walhalla Plateau was noted near Two-Mile Spring,

FIG. 107.—Sandstone slab making the walls of a small circular ruin near Two-Mile Spring, House Rock Valley.

in upper House Rock Valley. The structures are all circular, or nearly so, and measure from 4 to 10 feet in diameter; their standing walls are of dressed sandstone slabs, set on end and usually close together. No trace of plaster is to be found in any of the rooms and nothing remains of the masonry which unquestionably surmounted the upright stones. Where exposed, the floors are covered with burned earth and ashes and mixed with these are chunks of roofing clay still bearing impressions of willows, grass, etc. All of the structures are circular—no evidence of a former rectangular dwelling was noted in their immediate vicinity. Prehistoric remains similar to these have been observed, also, to the east of the Colorado River, between Grand Gulch and Chinlee Valley, in the San Juan drainage. As yet their original appearance and use seems to have been incompletely determined.

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FIG. 108.—Looking across the Grand Canyon from ruins near the head of Clear Creek, Walhalla Plateau.

FIG. 109.—Cliff village in lower Saddle Canyon, with the Rio Colorado in the distance.

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Many mullers and metates lay promiscuously about, and two of the latter were pitted on the grinding surface, showing secondary use as mortars. Flint chips and projectiles seemed unusually numerous, but potsherds, although of the customary types found on "Greenland," were surprisingly few in number.

Cliff-houses are not so plentiful as might be expected in the breaks bordering the Walhalla Plateau and these are, almost without exception, small single-room storage cists built by the inhabitants of the open houses among the pines and back some distance from the rim. Many of these cists have been occupied recently as shelters by white hunters—the smoke stains on the cave roof will not be confused with those left by aborigines. Dwellings protected by shallow caves are not unknown, however, and, although small, they add much to the picturesqueness of the country and to the less easily understood ruins of the mesa tops. Cliff-dwellings not visited during the recent reconnoissance are reported along the trailless ledges far below the floor of "Greenland"; others are know to exist in the "sand hills" and the red ledges of Pahreah Plateau. The difficulty of studying these remains is greatly enhanced by the infrequent sources of water supply and lack of forage for saddle and pack animals. As in other sections of the Southwest, the prehistoric dwellings are not always to be found in the vicinity of existing springs or water pockets.

ARCHEOLOGICAL STUDIES IN CENTRAL MISSOURI

Mr. Gerard Fowke, a collaborator of the bureau, made a reconnoissance in the Ozark region of south central Missouri. The purpose of the work was to locate and examine, as far as was feasible, all archeological remains, but with particular reference to caverns which afford evidence of having been used as places of shelter in prehistoric times. As the area in question includes the principal cave region lying east of the divide which separates these streams from the drainage basin of White River in the southwestern part of the State, a careful investigation was desirable.

It appears that Phelps and Pulaski Counties were centers of aboriginal population. There are many caverns, large and small, a majority of them showing abundant evidence of their former occupancy. Potsherds, broken animal bones, mortar stones, flint chips and spalls, broken implements of stone, bone perforators, and especially mussel shells, may be found under the present floors of the caves, and excavation shows them to continue to a considerable depth, usually to the bottom of the fine, loose, cave earth which rests

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upon the original clay or rock bottom. In many of the caves, however, this bottom cannot be reached, as water interferes with the digging, but ashes abound to whatever depth excavated. In a cave on Gourd Creek, 12 miles southwest of Rolla, this material formed a mass, almost solid, to a depth of 7 feet or more, and even then its limit was not reached; but no greater depth can be reached until a ditch is dug to the outside of sufficient depth to drain off the water which has accumulated from interior drainage. Goat Bluff Cave, facing the Gasconade near the line between Phelps and Pulaski Counties, 4 miles west of Arlington, shows a similar condition. Many of the caverns have a large amount of talus and other débris about the opening which sometimes makes entrance difficult; others have earth floors which are many feet in depth, with no refuse material near the present surface, although it extends down the slope on the outside. While the larger caverns would have sheltered more persons and consequently may yield a larger number of artifacts, it is not to be expected that traces of very ancient residence will be found in them in the same abundance as in smaller caves. A cave with a narrow entrance to the interior could be more readily defended by its inmates than one where the passageway is larger and the interior more accessible. It would therefore be natural to conclude that a smaller cave would be inhabited longer than a larger one, and so contain more ancient remains.

Passing in any direction from these two counties, caverns continue, though they gradually diminish in number, and while many of these are suitable for shelters or permanent homes, fewer of them have the usual indications of occupancy. With the changing elevation of the cave-bearing strata, due to the dip of the formations, a smaller number of them are as well adapted for shelters. It seems useless to investigate anything beyond the limits reached in these researches.

In addition to the residential caverns along all the streams in these two central counties there are numerous village sites on the level bottom lands. Flint implements and chips are very abundant; pottery fragments less common except in a few places where it would appear that vessels have been manufactured; axes or hatchets are rather rare; other objects, such as mortars and pestles, have not been reported, probably because they are overlooked in the search for "arrows"—a general term, including all edged or pointed flints—which are very plentiful, though usually not smoothly finished. Several large mussel shells, found in the caves, are perforated for attachment to a handle, for use as hoes.

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Very few of the caverns visited along the upper Current and upper Meramec Rivers are adapted for shelters, being damp or with small openings which shut off light from the interior; or difficult to reach; or at a distance from water. This is also true of the caverns along the lower Osage and lower Gasconade. The best field for research, however, is situated in Phelps and Pulaski Counties, where scores of caverns not only promise good material, but also are of sufficient depth to have stratification containing the handiwork of successive populations.

No aboriginal burial places have been discovered in level bottom lands, though many must certainly exist, when consideration is given to the evidences of numerous villages and long periods of occupation.

Cairns are found on nearly every ridge, especially on points which overlook streams or valleys. Nearly all were the ordinary conical or dome shape, formed by throwing stones over a grave, and are not at all distinctive, resembling in this respect similar burial places in various parts of the country. Two types, modifications of a single plan, were discovered, however, which have not been observed elsewhere. The graves in these are indicated by stone walls forming an enclosure as nearly square as the skill of the builders would permit. In one form, only a single row of flat stones was laid, and the grave, including a narrow space around the outside of the wall, was covered with stones, so that the pile outwardly resembled the ordinary cairn. In the other form this wall is carried up several rows, making a structure like a cellar wall or the foundation of a house. The space within this was filled with stones thrown in loosely, but none were placed against the outside. This latter type differs from the earth-covered stone vaults along the Missouri River where the inside of the vault is laid up as evenly as possible, no attention being paid to the outside; whereas, in the former, this feature is reversed.

FIELD-WORK AMONG THE KIOWA

From July to October inclusive, Mr. James Mooney, ethnologist, continued his field investigations of the Peyote cult and Kiowa heraldry among the Kiowa and associated tribes of Oklahoma.

The heraldry investigation relates particularly to the confederated Kiowa and Kiowa Apache, and involves a study of the origin, history, decoration, myths, and ceremonial regulations in connection with the shields and heraldic tipis formerly existing in the two tribes (there being approximately 250 shields and 50 decorated tipis), with incidental attention to the tribal systems of genealogy, heredity, and medicine, together with the warrior organization and

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FIG. 110.—Tenikwa, Chief Priest, Native Peyote Religion, Comanche Tribe.

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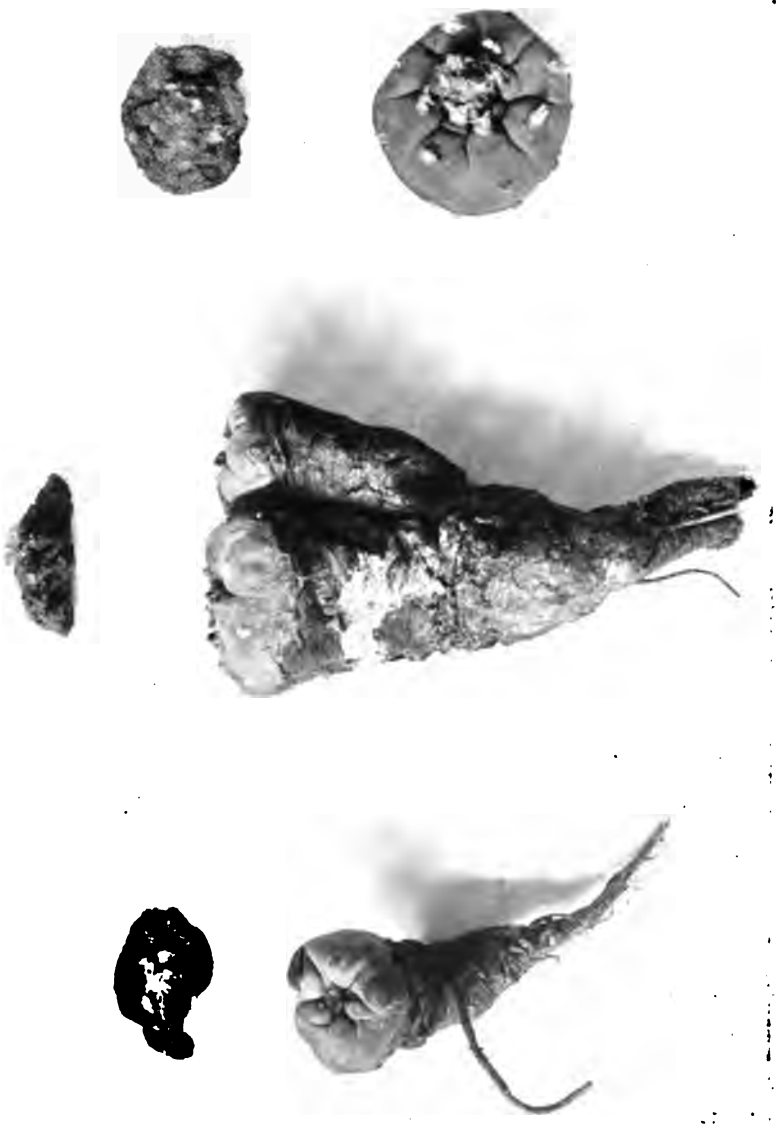

FIG. 111.—The Peyote (*Lophophora williamsii*): whole plants, green top, and dried "buttons." About one-half actual size.

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shield songs. A complete series of miniature models of the shields and tipis concerned, prepared by the best artists of the two tribes under dictation of the former owners or their representatives, forms an interesting Museum exhibit in connection with a report now in preparation which will contain all the information now in hand, including an indefinite number of tabu regulations, and a number of shield songs in keeping of individuals.

FIG. 112.—The Cow-shield (inside cover) formerly carried by Tsentainti, "White Horse," Kiowa raider, with cow-horn headdress, bridle, pendant and pouch.

The Peyote study involves some 20 distinct tribes in Oklahoma, as well as others in various Western States, together with the majority of the tribes of the upland regions and central Mexico as far south as the City of Mexico.

The peyote is a small cactus which is used medicinally for the relief of various ailments and sacramentally in connection with a

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native religion. Its use in both connections among the tribes of Mexico was noted by the earliest Spanish writers after the Conquest and by such later investigators as Lumholtz and Fuchs. It was noted in Texas as early as 1760.

In continuation of his study begun years ago, before the Peyote religion had reached its present high development or territorial extension, Mr. Mooney, on invitation of the tribes, transmitted by delegates from the Councils, made observation of the ceremony and of the medical use of the plant, and had filled out a number of individual questionnaires relating to the same subject, among the Kiowa, Comanche, Apache, Caddo, Cheyenne, and Arapaho, being everywhere received with the most generous hospitality and given every opportunity for observation and investigation, by reason of his long-standing friendship with the tribes and his known interest in the subject.

FIELD-WORK AMONG THE IROQUOIS

Mr. J. N. B. Hewitt, ethnologist, of the Bureau of American Ethnology, resumed his work in Ontario, Canada, on the textual and literary criticism of the many texts which he had previously recorded relating to the establishment of the Federation or League of the Five Tribes (or Nations) of the Iroquois, and especially to the organic institutions of this league. By the accession of the Tuscarora in 1722 these Indians became the Six Nations of the Iroquois.

The larger and more detailed part of these texts was dictated by his late friend, the blind Seneca federal chief, John Arthur Gibson, one of the best-informed ritualists and expounders of the principles and the institutions of the so-called League of the Iroquois; the remainder, consisting of differing versions of the matter just mentioned and also of much additional and supplemental material in the form of texts, was recorded from the dictation of other competent informants, among whom may be mentioned the late Onondaga federal chief, John Buck, who was at the time of his death the federal Fire-Keeper; the present Cayuga federal chief emeritus, Abram Charles; and Chief Prophet Joshua Buck, all versed in the varying traditions of the motives and plans of the founders of the League or Federation and the decrees and ordinances promulgated by them for its establishment.

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Since nearly all the traditions recorded in these texts were transmitted by memory for about 350 years it was inevitable that some of the essentially important details of the structure of the league and of its organic institutions should not have been remembered with the same fidelity by different persons, and so differences of opinion and marked variation in statement are not infrequently encountered concerning the same subject-matter. The problem for

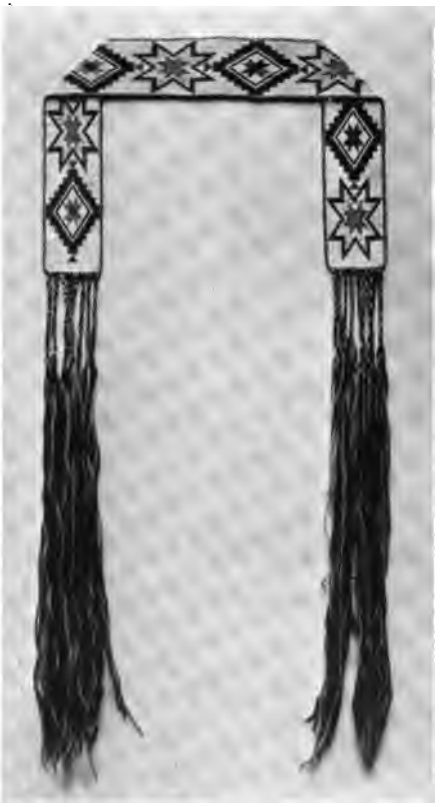

FIG. 113.—Baby Cradle Sash (Chippewa).

the student, then, is to determine by a sufficiently broad survey of differing traditions what the most probable facts were upon which these conflicting views and statements were originally based. The motives of the founders are not at all times remembered. As the institutions of the league are slowly becoming obsolete in the face of assimilated European culture and civilization this reconstructive work is one of great difficulty.

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The diction is largely that of the forum. The notional terms employed are those of statecraft and ritualism—the language of statesmen and stateswomen and prophets of that earlier time, who even then had measurably clear visions of institutions of to-day,

FIG. 114.—Red-faced mask of a Wind God. A deity of Disease and the East.

FIG. 115.—Black-faced mask of a Wind God. A deity of Disease and the West.

such as the recall, the initiative, the referendum, woman suffrage limited to mothers for the election of nominees to chiefships, and a colonial policy. It may be added here that the men had no voice in the nomination of chiefs.

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Certain words occurring in Iroquois texts show that the laws and the rules of procedure among the Five Iroquois Tribes were not the decrees of an autocrat or tyrant, but rather were the formulated wisdom of a body of peers, who owed their official positions to the suffrages of those who owned the titles to them, and that the form of government was a limited democracy, or, strictly speaking, a limited gyneocracy.

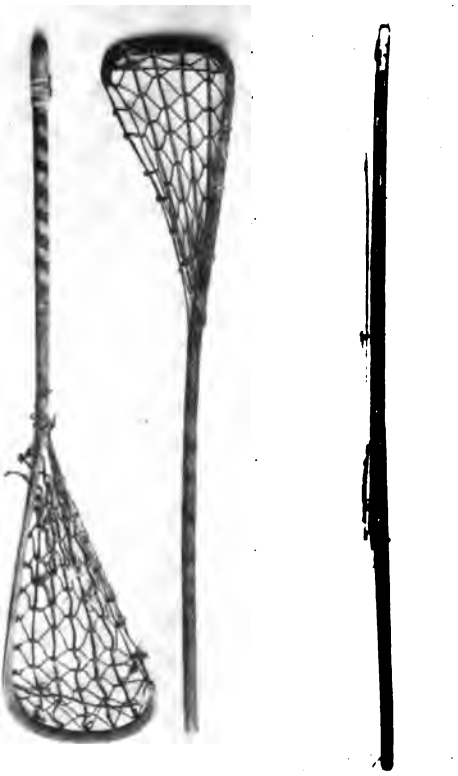

FIG. 116.—Lacrosse clubs of the Iroquois. A bow with arrows.

In this manner the following matters were studied and analyzed: The law defining the position, the powers, and the disabilities of a chieftainess, or Goyānegō'nă'; the law defining the position, the powers, and the disabilities of the tribal chiefs, and of the federal or *Royaner* chiefs of the league (or Extended Lodge), and the manner of their nomination, installation, and removal for cause; the law of the extinction of the ohwachira (or uterine family), having federal or Royaner chief titles, called Ë^{n}yoñdoñgwe'do'k'dĕ^{n}', *i. e.*,

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they will run out of persons, and so no more men will be available for candidates for chiefships; the law defining the position, the powers, the disabilities, and the authority of the Onondaga chief, De'hadodā''ho'; and of his co-tribal Royaner chiefs; individually and in their collective capacity of Federal Fire-Keepers; the law of the method, the limitations, and the effect of the action of these Fire-Keepers in confirming, or in referring back for cause for review, to the Council of their peers, any of its acts, whether unanimous or not; the law limiting suffrage for the nomination of chiefs to the mothers in the clans; and the law recognizing descent of blood and fixing the status of persons in the female line; the law of the sacredness of the lodge and of private property; the law of hospitality, good neighborhood, and good fellowship; the law of murder, and of rape, and of highway robbery; the law of the police, or the regulation of the internal affairs of the league, symbolized by the Long Wing of the Gull and the Staff which were placed in the hands of the great federal chief, De'hadodā''ho'; the law of the domestic relations; the law of hunting and fishing; the law of planting and the protection of the crops; the law fixing daytime and the place for holding the sessions of the Federal Council and for the demeanor of the Royaner or federal chiefs at such sessions; the law defining the position, the powers, and the limitations of the Merit, or the so-called Pine-Tree chiefs; the law for the adjustment of homicide, obviating the former *Lex talionis;* the law of homicide by a Royaner or federal chief; and the law of the Union or Federation of Clans and of Lands (or Peoples), with an extensive explanatory preface.

A number of other rituals and traditions of the Iroquois were analytically studied, and Mr. Hewitt also collected a number of Museum specimens, including a very fine wooden mask of a Disease God, painted red; it is a work of art. Some of these are illustrated in this paper.

FIELD-WORK AMONG THE CHOCTAW AND CATAWBA

Dr. John R. Swanton, ethnologist, of the Bureau of American Ethnology, was in the field from the middle of April to the end of May, 1918. On leaving Washington he went immediately to Charenton, Louisiana, where he spent about one week amplifying his grammatical sketch of the Chitimacha language already prepared, and clearing up some doubtful points which had developed during its composition.

After completing this work he proceeded to Philadelphia, Mississippi, in order to ascertain something regarding the present con-

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FIG. 117.—Nanih-waya, or "Mother Hill" of the Choctaw.

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dition of the Choctaw Indians in that neighborhood, the descendants of those who remained in their old country after the greater portion of the tribe had emigrated to what is now Oklahoma. On the way he stopped at Bay St. Louis to visit a small band of Indians living in the country north of that place. He learned that this was a band of the Sixtown Choctaw, the southernmost division of the Choctaw nation, but that all of the old people were dead and practically nothing regarding their ancient manner of life was known to the survivors.

Near Philadelphia (Mississippi) remnants of three Choctaw bands or clans are still to be found, and in the few days spent in interviewing them—this being merely a reconnoissance—a few interesting data regarding their social organization and former customs were secured. A visit was also made to the famous Nanih-waya, or "mother hill," of the Choctaw, where, according to some versions of the Choctaw origin legend, the ancestors of this tribe emerged out of the earth. This is an artificial elevation of considerable size in the midst of a fairly level tract of country, surrounded partly by Nanne Warrior Creek, so named from the hill, and partly by a low earthen rampart, traces of which are now barely visible. Several photographs of this hill were taken.

The remainder of the time, until the end of May, was devoted to a study of the Catawba language on the Catawba reservation near Rock Hill, South Carolina. Early in the eighties the late Dr. A. S. Gatschet, of the Bureau of Ethnology, collected a vocabulary and other linguistic material on the reservation, and recently Dr. Michelson spent a short time there studying the people and their language, but our knowledge of it is still very imperfect and any additional material is sure to be of value. Although fairly well known to about 20 persons, this language is no longer in common use and few Catawba retain it in anything like its ancient purity. Its peculiar value consists in the fact that it is the only surviving dialect of the eastern Siouan group and that by which the other Siouan fragments from the same area must be interpreted. It appears to be the most aberrant of all the Siouan dialects and to contain features of great value in tracing the evolution of the entire stock. Dr. Swanton was able to collect considerable material, principally detached words and phrases, also a slight amount of textual material, being assisted very much by Dr. Gatschet's manuscript vocabulary. Some notes of general ethnological character were also secured, but the tribe has lived so long in close contact with white people that it is doubtful whether much of this is purely aboriginal.

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RESEARCHES AMONG THE OSAGE

In the month of May, 1918, Mr. Francis La Flesche, of the Bureau of American Ethnology, visited the Osage Reservation to continue his field researches among the people of the Osage tribe. During his stay among these people, Mr. La Flesche prevailed upon Wa-xthi'-zhi to give in full the Ga-hi'-ge O-k'o^{n}, "The Rite Belonging to the Chiefs," which, up to that time, he had persistently declined to do excepting to give it in paraphrase. His unwillingness to repeat the rite and to recite in detail its wi'-gi-es (spoken parts) was strengthened by the recent loss of his only son and also of a grandchild, losses which he attributed to his giving the tribal rites without the traditional prescribed ceremonial forms, and the open criticism of some of the men who, in times past, had often taken part with him in the actual performance of the ceremonies. But after much persuasion he finally consented to give the rite in full.

Wa-xthi'-zhi prefaced his narrative with the story of the development of the governmental organization of the tribe which had passed through four experimental stages before it finally satisfied the people. These stages were as follows:

First. When the affairs of the people were in the control of one great tribal division known as the Ho^{n}'-ga U-ta-no^{n}-dsi, a division whose tribal symbol is the earth. During the control of this division the affairs of the people were in a continual state of chaos and confusion and there were no fixed rules of action.

Second. When the Wa-zha'-zhe, a division whose tribal symbol is the waters of the earth, persuaded the Ho^{n}'-ga U-ta-no^{n}-dsi to submit to a movement toward an organization that would better satisfy the people of all the great tribal divisions. This movement the people called, figuratively, "A departure to a new country." It was at this time that the people organized a military form of government to be controlled jointly by four great tribal divisions. These four divisions were empowered to initiate war movements, the organization for such a purpose to be known as Do-do^{n}'-hi^{n}-to^{n}-ga, "War Party by Hundreds," and these four divisions also controlled the tribal hunting expeditions. It was during this stage that the tribal war rites and the rites pertaining to the ceremonial naming of the children were formulated.

Third. In course of time the people became conscious of a disadvantage in the method prescribed for the organizing of a war party. This method was burdened by a multiplicity of ceremonial forms which made it impossible to act promptly when haste became urgent. For this reason another "Departure to a new country"

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took place, a movement that made it possible to suspend the tedious ceremonial forms that were hitherto observed when organizing a war party. A single gens or a number of gentes were now empow-

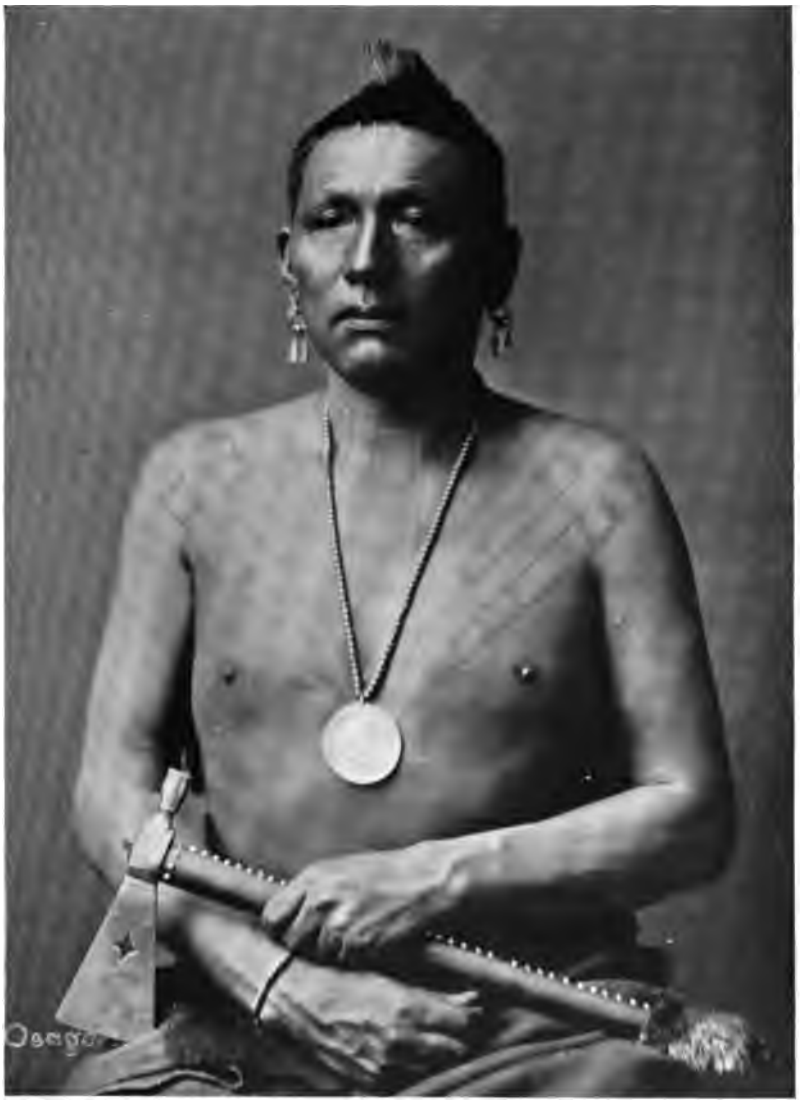

FIG. 118.—Osage Warrior with Pictured War Symbols on His Body.

ered to organize war parties. A war party organized by the new method was called Tsi'-ga-xa Do-do^{n}, a name which may be freely translated "Outside the (Sacred) House." With this new depar-

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ture, which was really an addition, the military form of the government was regarded as complete.

Fourth. Finally the people made another "Departure to a new country," at which time the people put into effect an organization which they believed would safeguard the tribe from disruption by internal dissensions. In this fourth and final stage the internal affairs of the tribe fell to the control of two hereditary chiefs, one for each of the two great tribal divisions, namely, the Ho$^{n'}$-ga and the Tsi'-zhu: the first, in the tribal symbolic system, representing the earth, and the latter the sky, with all its celestial bodies. These chiefs were chosen, on the Ho$^{n'}$-ga side from the Po$^{n'}$-ka Wa-shta-ge gens, and on the Tsi'-zhu side from the Tsi'-zhu Wa-shta-ge gens.

Upon the completion of this organization the two chiefs took upon themselves the rite of fasting, by which each one sought for some sign of approval from Wa-ko$^{n'}$-da, "The All-Controlling Power." To the Po$^{n'}$-ka Wa-shta-ge, on the seventh day of his fast, was revealed the art of healing by scarification. The instruments used were to be made from the wing-bones of the pelican or the wing-bones of the eagle. To the Tsi'-zhu Wa-shta-ge was revealed the art of healing by the use of medicinal roots. The two chiefs were also given the power to heal the sick by ceremonially feeding to them certain foods declared to be sacred and life-giving. In recognition of this healing power of the two chiefs the people of their respective gentes adopted Wa-stse'-e-do^{n}, "The Good Doctor," as a sacred personal name to be bestowed upon their children. A rite was formulated for each of the two chiefs to perpetuate the memory of these events.

During the second and third stages of the development of the government, a rite, religious in character, was reverently observed by the people, namely, the rite of tattooing. According to this rite a man who had achieved success as a chosen war leader was permitted to have tattooed upon his chest, neck, and shoulders conventional designs of certain symbols, all of which pertained to war. These were: The sacred ceremonial knife. The outline of this implement runs from under his chin down the middle of his chest to his abdomen; the sacred pipe which he used for offering smoke to Wa-ko$^{n'}$-da when appealing to him for success, and which he carried throughout the war expedition. The outline of this pipe runs from either side of the middle of the knife design and terminates behind his shoulders; the thirteen rays of the sun which symbolize the number of o-do$^{n'}$ (military honors) every warrior must strive to win. These conventional rays run upward from either side of the

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knife between its point and the pipe design, terminating behind the shoulders (fig. 118).

The woman, upon whom depends the continual existence of the tribe, was no less honored than the warrior who risks his life for the people. Upon her forehead, chest, back, arms, hands, and the lower part of her legs are pictured, in conventional designs, the sun, stars, the earth, the powers from whose united force proceed life in all its manifold forms. The lines running down from her shoulder to her

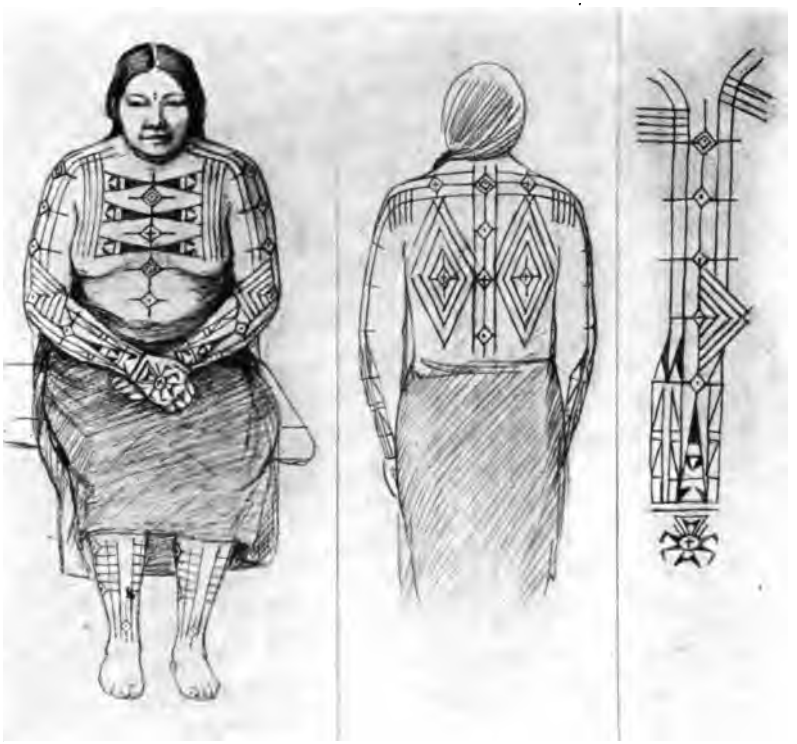

FIG. 119.—Osage Woman with Conventional Symbols Pictured on Her Body.

wrist symbolize the "paths of animals," in reality, life descending from the sun and the stars to the earth, represented in the conventional design of a spider pictured on the hand (fig. 119).

When the fourth stage of the tribal government was completed this rite was transferred to the Po^{n}′-ka Wa-shta-ge chief and also added to the rite formulated for him. The translation of the story of this combined rite, as given in full by Wa-xthi′-zhi, is in process of completion. It contains 31 wi′-gi-es (recited parts), songs, diagrams, illustrations, charts, and text.

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MATERIAL CULTURE AMONG THE CHIPPEWA

During the summer of 1918 Miss Frances Densmore, of the Bureau of American Ethnology, visited four localities and her work included a wide field of research. The first reservation visited was Fort Berthold in North Dakota. The purpose of this trip was a final consultation with the Mandan and Hidatsa Indians concerning their music

FIG. 120.—Woman placing tobacco in ground before felling birch tree.

to complete her bulletin on that subject. Information on important points was verified, and additional material was secured, especially regarding the musical instruments used by these tribes. Among the latter data was a description of a "double whistle," said to have been used by the Mandans in former times, and a peculiarly decorated drum used by the Goose women's society. A close examination of a similar drum in the North Dakota State Historical Society revealed a trace of this decoration, almost obliterated by age and use. This specimen was kindly loaned by that society for illustration.

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FIG. 121.—First Incision in Bark of Birch Tree.

FIG. 122.—Removing Bark from Birch Tree.

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A study of Chippewa material culture, extending over several previous years, was continued on the White Earth and Red Lake reservations in Minnesota, special attention being given to the history and development of Chippewa art. A conventional form of design was found to have existed before the present floral patterns, said by the Indians to be comparatively modern. Examples of these

FIG. 123.—Chippewa Woman Carrying Pack of Birch Bark.

early designs were obtained from the old women, and include conventional flowers and leaves, as well as geometric patterns. Industrial art was also studied, one of its interesting phases being the process of securing and storing birch bark, as well as the manner of its use. Before digging a medicine herb the Chippewa puts tobacco in the ground as an "offering." The same custom is observed before cutting a birch tree, the tobacco being first held toward the zenith and the cardinal points, with low "talking." This can scarcely be termed "supplication," as the mental attitude of the Chippewa when

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addressing a "spirit" is that of a respectful friend rather than a suppliant in the white man's understanding of that word. The Chippewa says simply, that he desires the herb, root, or bark for a necessary purpose and asks that he be successful in his use of it.

The writer requested that a birch tree be cut for her according to the old custom, and this was done by a reliable informant at White Earth. Tobacco was placed at the root (fig. 120), and the tree was

FIG. 124.—Chippewa woman adjusting deer hide in position for process of smoking.

felled in such a manner that the bark would not come in contact with the ground. In taking the bark a longitudinal cut was made (fig. 121), after which the bark was turned back (fig. 122), passed beneath the trunk of the tree and removed in a large sheet. This work was always done by the women, who fastened the sheets of bark in packs, usually placing 100 sheets in a pack and tying them with strips of the inner bark of the basswood. In this manner the bark was taken from the woods (fig. 123) and, if not needed for im-

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mediate use, was stored in dry, cool shelters. Birch bark was used in making many forms of containers, and sheets of the bark were sewed together as coverings for dwellings. Next in importance to birch bark may be considered the deer hide, which furnished the early Chippewa with material for their clothing, bedding, etc. The tanning of hides was studied, and the process of "smoking" a hide was photographed at Red Lake (fig. 124). The hide was suspended above a shallow hole in the ground, in which a slow fire was kept burning. The smoke from this fire imparted a golden yellow color to the hide. The woman shown in the illustration is expert in the work, and when tanning this hide was wearing her hair loose on her shoulders, according to the custom of one in recent mourning. The writer continued the collecting of medicinal herbs, which was begun in 1917, and recorded much data concerning the early customs of the Chippewa.

The last locality visited was in the vicinity of Lake Winnebigoshish where some old graves had been "washed out." More than 250 fragments of pottery were collected, 110 of which were pieces of the rims and necks of jars. The decorations of these were not unusual in character, showing various imprints of roulette, twisted cord, woven fabric, sharp stick, or thumb-nail, but these were combined in such variety that only three or four duplicates were found in the entire collection. Thirty-four fragments of jars were large enough to show the curve of the sides and the size, which varied from a few inches to about a foot in diameter. The color of the pottery fragments also showed a wide variety, including black, orange, and very pale gray, as well as the familiar browns and reddish shades. Among numerous human bones collected was a skull obtained from an Indian who found it in that immediate locality. The skeletal material was submitted to Dr. Hrdlička, of the National Museum, who reports that "the bones are those of a male skeleton, in all probability Indian. They are possibly not over a few decades old." The large bones were pierced near one end, the puncture breaking into the marrow cavity. These artifacts show the use of a conical instrument.

STUDIES OF THE KIOWA, TEWA, AND CALIFORNIA INDIANS

In June Mr. John P. Harrington, of the Bureau of American Ethnology, went to Anadarko, Oklahoma, where, with the assistance of very intelligent informants, he was able to revise and greatly increase his Kiowa material, which includes very complete grammatical notes and some texts. At the end of June Mr. Harrington proceeded to

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Taos, New Mexico, where, coming as he did fresh from the Kiowa field, an excellent opportunity was afforded during the following weeks for comparison of the Tanoan with the Kiowa. In addition to abundant grammatical material, the vocabulary of the language was thoroughly studied. For instance, the lists of names of plant and animal species were made very complete, and although the work was primarily a linguistic one many new identifications were obtained.

FIG. 125.—Ventureño Informant.

Comparative studies of the two idioms in Oklahoma and New Mexico furnished an overwhelming weight of evidence supporting the discovery of the genetic relationship of Tanoan and Kiowa, and show that the Tano-Kiowan is an offshoot of that great stock of languages which gave rise to the Uto-Aztecan. The relationship between Tanoan and Kiowa is comparatively close and is the more remarkable because the Kiowa are a small tribe having the culture

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of the plains Indians whose earlier home was in what is now western Montana, while the Tanoans are a typically Pueblo division inhabiting the Rio Grande drainage of New Mexico. It is proposed that the linguistic family thus established, including Uto-Aztecan, Tanoan, and Kiowa, be termed Patlan, a name derived from the word meaning " water " or " river " in all these languages.

In August Mr. Harrington proceeded to California to continue his studies among the Mission Indians of the Chumashan region of southern California. It was his good fortune to be able to make most important additions to the Ventureño grammar, securing many old words which it had been impossible to obtain at previous visits and which are most important for throwing light on all the related languages.

A searching ethnological questionnaire was used with the informants, yielding very gratifying results, especially in the field of material culture. Detailed information on ancient dance regalia and the process of preparing native tobacco and its uses was obtained. An adequate description was procured on ancient traps for ground squirrels and other small animals whose names had been given by various informants, but had never been satisfactorily described. Quite a little new and important information on archery was obtained. Mr. Harrington had special success in learning from a couple of aged women the ancient childbirth practices, including a unique description of the method of cutting the navel cord by means of a carrizo knife after the blood had been dried out of the section by the application of warm decoction *pespibata.* A bed of warm coals was made on the floor and a layer of medicinal herbs was placed on top of this, on which the mother and child lay for three days after childbirth. Sociological problems were intensively investigated and new information was gathered, especially on mortuary customs. Likewise, a few old songs, among which is an especially pretty quail song which has the refrain *ka, ka,* imitating the cry of the quail brought out with a peculiar stressed voice. This and some of the other songs doubtless form parts of old cycles, the other songs of which have not been recovered.

Mr. Harrington obtained from Manuel Chura, who was born in 1820, and is therefore nearly 100 years old, much linguistic information, and 15 very rare songs, such as used to be sung at the Indian fiestas in the thirties or forties of the past century. He also obtained several splendid songs from José de los Santos Juncos, who is also nearly a centenarian.

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FIELD-WORK AMONG THE SAUK AND FOX

Dr. Truman Michelson, ethnologist, of the Bureau of American Ethnology, spent two and a half months at Tama, Iowa, among the Sauk and Fox Indians. Shortly after his arrival, July 1, the death

FIG. 126.—Some Fox Children in Gala Attire.

FIG. 127.—A Ceremonial Drum used in the Fox "Religion-Dance."

of William Wanatie's son occurred. Dr. Michelson was given tobacco and told to go to the house and be one of those to sit up all night with the corpse. Wanatie is the owner of one of the drums connected with the so-called religion-dance; and the oppor-

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tunity to observe the ceremonies was unequaled. A few days later Ella Davenport died, probably of tuberculosis; however, her parents believed that she had been witched, and he was asked to be one of those to watch her grave at night for a number of days, being assured that Indians knew very well that witches were afraid of white people and would not harm them. It appears that Fox Indians believe that if a person has been killed by a witch, the witch will return in the form of a dog, owl, or bear, tap four times on the grave of the deceased, whereupon the dead will come back to life and the witch will then proceed to torture the person by cutting out his or her tongue and stringing his or her heart. He of course embraced the opportunity; and with a few Indians sat up with loaded shotguns for a few nights watching the grave. Unfortunately the witch did not come. After such a favorable opening he seized the occasion to obtain a number of texts written in the current syllabary on the origin of death, the ceremonies connected therewith, etc., which have since been translated. These texts all supplement rather than contradict each other. The grammatical analysis of the text appurtenant to the Owl sacred pack, begun with Edward Davenport at the U. S. Indian School at Carlisle, was completed. A number of texts collected in previous seasons, some appurtenant to ceremonials and the like, and a few folk tales were translated in the course of the summer, as were the personal names of approximately nine-tenths of the entire Fox population.

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ARCHEOLOGICAL INVESTIGATIONS AT PARAGONAH, UTAH

(WITH FIFTEEN PLATES)

BY
NEIL M. JUDD

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ARCHEOLOGICAL INVESTIGATIONS AT PARAGONAH, UTAH

By NEIL M. JUDD

(With Fifteen Plates)

INTRODUCTION

The remains of ancient habitations now visible near Paragonah in Iron County, Utah, comprise but a small remnant of the total number which formerly overlooked the broad Parowan Valley, from the foothills between Red and Little Creek canyons. It is recorded[1] that Dr. H. C. Yarrow, of the Wheeler Survey, observed more than 400 mounds in this vicinity in 1872. The figure given, in itself, suggests a possible exaggeration and yet many ruins were unquestionably razed during the succeeding 20 years as the cultivated fields of the modern community increased in extent. Prof. Henry Montgomery, then of the University of Utah, reports[2] approximately 100 mounds near Paragonah in 1893 and a like estimate is given by Mr. Don Maguire of Ogden, Utah, who conducted excavations at the same time as Professor Montgomery in the interest of the Chicago World's Fair. Less than half of these remained in 1915, when the writer began his investigations for the Bureau of American Ethnology and the number was still further reduced during the next 12 months, leaving a bare half-dozen large elevations in the fields already under cultivation and several smaller mounds in the sage-covered area adjoining. But the largest of these, whose size alone has delayed their reduction, had also attracted earlier investigators and each mound still bears the scars of their several undertakings.

In addition to the above observers Dr. Edward Palmer, of the U. S. National Museum, conducted limited excavations at the same locality during one of his numerous expeditions through southwestern Utah between 1869 and 1877. None of these investigators, however, with the single exception of Professor Montgomery,[3] has published an

[1] U. S. Geographical Surveys West of the 100th Meridian, Capt. G. M. Wheeler, Vol. 1, p. 57. Washington, D. C., 1889.

[2] The Archaeologist, Vol. 2, p. 303, 1894.

[3] *Ibid.*, pp. 303-306.

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account of his researches. The writer's own impressions, gained in 1915 and 1916, have been, as yet, but partially recorded,[1] a more detailed report being withheld pending completion of additional investigations. It is obvious, therefore, that the remains of an unusually large number of prehistoric dwellings near the village above mentioned have gradually given way before the advance of agricultural preference and that, notwithstanding the many observations made among them, the ruins have contributed but little to our scanty knowledge of their ancient inhabitants and have left us with only the vaguest understanding of the degree of culture to which their builders had attained.

The present paper finds its origin in a joint expedition undertaken in 1917 by the Smithsonian Institution and the University of Utah, at the request of the latter. The writer had the honor and the pleasure of directing the work, with the cordial cooperation of President John A. Widtsoe and Prof. Levi Edgar Young, of the university,[2] and with the active assistance of Mr. Andrew A. Kerr as their field representative.

It must be confessed that, for the layman, there is but little of the spectacular in the results of the expedition. The student of history, on the other hand, will find much to hold his attention—rude dwellings of earth that seem so thoroughly adapted to their environment and vast quantities of minor antiquities, each of which is its own key to the daily activities and industries of the ancient house builders. Here was a people who came from some distant, undetermined region—a people that established a compact community, with a definite social organization, and then passed on to a new locality where another cycle in their tribal history was unfolded. Innumerable paragraphs might be written from the information at hand and yet,

[1] Smithsonian Misc. Coll., Vol. 66, No. 3, p. 67; No. 17, pp. 103-107.

[2] It should be stated that the successful inauguration and furtherance of the season's undertaking was due largely to the interest and perseverance of President Widtsoe and Professor Young. They first enlisted the aid of the government institution and, thereafter, freely rendered every possible assistance in bringing the work of the expedition to a happy conclusion.

In this place, also, the writer desires to acknowledge his appreciation of the generous spirit in which his numerous Paragonah friends contributed to the success of the expedition and he is especially indebted to Mrs. Martha Jane Openshaw and Mr. Isaac Bozarth who kindly granted the necessary permission to conduct the excavations. The ultimate purpose of science can always be best served by such whole-hearted good will and mutual helpfulness as that which greeted the 1917 party.

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at this time, it seems unwise to attempt more than a general survey of the season's discoveries, reserving for a subsequent paper the tempting comparison between the cultural evidence disclosed at Paragonah and that found among ancient ruins in other sections of the Southwest. Likewise, direct reference to previous investigations of the Smithsonian Institution in Parowan and neighboring valleys will be avoided in so far as possible, that the following pages may be devoted entirely to the joint enterprise of 1917. A certain heterogeneity frequently obtains among archeological remains in western Utah—such a confusion and intermingling of like and unlike structures that the entire subject may be explained most clearly in a monograph based upon knowledge gained throughout the vast region in which similar remains occur. The present paper treats of but one small section of that region and the results of 1917 should be considered merely as a single, though highly important, contribution toward final solution of the whole complex question.

EXCAVATION OF THE BIG MOUND

Paragonah was reached early in July and the party at once centered its attention upon an elevation known locally as "the big mound," a huge knoll measuring approximately 225 feet in diameter and 10 feet high. There were several reasons for this selection: (1) It was the largest of those remaining and, notwithstanding the previous removal of the southern one-third and superficial evidence of other excavations, it still promised more perfect examples of architecture and deeper court deposits than adjacent mounds; (2) being in the way of proposed improvements, it was in imminent danger of complete reduction, with final loss of its archeologic contents; and (3) exposure of the house-group which the "big mound" was thought to cover would form a fitting sequel to earlier studies of smaller elevations containing from one to five dwellings, together with their related structures.

The ragged blanket of sage-brush which covered the mound was first cut and burned. Trenches were then begun in several places, in search of walls, floors, etc. The actual work of excavation was done with shovels; teams and scrapers being employed only in removing the earth which had been examined and thrown out by the workmen. This method, although slower, resulted in more extensive collections of small artifacts and insured, also, greater accuracy in tracing the various floor levels and house walls, some of which were determined only with the greatest difficulty owing to their coloration

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and to the compact condition of the surrounding soil. When house remains were encountered they were immediately exposed, provided no connecting structures were discovered which required previous attention. Working from one dwelling to another, the entire series was finally uncovered.

Early in the course of the excavations it became evident that in the "big mound," as in other similar elevations, ruins of two distinct types were to be found. These naturally increased in numbers as the work progressed, but the obvious relationship between the two types did not differ materially from that established during former operations. The chief task of the 1917 expedition, therefore, soon resolved itself into an effort to locate all of the more permanent houses and to discover in the lesser structures invariably associated with them any variation from their customary form. The outstanding features of each type are given below, with additional notes on certain individual ruins.

In general, every prehistoric community attracts the student both through its architecture and its lesser antiquities, for the house remains, perhaps more completely than the artifacts found within or near them, furnish a true index to the cultural attainments of their builders. And it is the degree of social and material advancement, as evidenced by such remains and by such artifacts, that enables the anthropologist to assign to any given people its approximate place on the ladder of intellectual progress. In considering the results of excavations in the big mound at Paragonah, therefore, attention will first be directed to the structures occupied by the aborigines and then to the minor objects discovered in connection with those structures.

HOUSE REMAINS

Reference to the ground plan (pl. 1) of the mound under consideration shows a number of adjacent, rectangular rooms and several additional buildings. It will be noticed, also, that some of these rooms appear one above the other, but, even in such instances, there is evidence of a purposeful arrangement and the constant recognition of a previously determined relationship. The fireplaces in the areas contiguous to the rectangular rooms indicate the location of temporary structures, occupied in conjunction with the more permanent buildings. All the fireplaces discovered during the course of the excavations are not shown on the ground plan, for they were found indiscriminately and throughout the entire depth of the mound in such numbers as to render impracticable their proper delineation.

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The walls of the quadrangular buildings were constructed entirely of adobe, usually in layers, and averaging about 10 inches in thickness. No complete wall has yet been found, but it is reasonable to suppose that none of these exceeded in height the walls of other prehistoric habitations throughout the Southwest, that is to say, from 4½ to 5 feet. This does not mean, however, that the inhabitants were of small stature, a fallacy which has an unfortunately wide circulation. Small houses were easier to build and they afforded greater protection from the elements; they were utilized primarily as sleeping quarters and for the storage of corn, beans, and other foodstuffs. They were designed chiefly to meet these requirements; the daily activities of their owners being performed mostly out of doors or in the shelter of secondary structures.

Much has been said regarding the manner in which these adobe dwellings were constructed, but it has been pointed out elsewhere[1] that the methods employed were not so complex as has been commonly supposed. The builders required merely an abundant water-supply and the clayey soil of the region. A shallow hole near the site of the proposed house sufficed as a mixing box, into which water was poured as needed; the hole grew in extent and depth as its sides were cut down to furnish additional clay. This was undoubtedly mixed by the bare feet of the workers, a method still employed by modern Pueblo Indians and their Mexican neighbors.

Balls of this mud, worked to a stiff paste, were then thrown on to a prepared area, tracing the outline of the room. Other masses were added and the four walls gradually assumed their desired height. Of necessity these were built up in layers, for the cohesive properties of plastic clay are very low and supporting forms were unknown among the primitive peoples of America. Each layer averaged about 15 inches in thickness and the desert sun soon dried it sufficiently to permit of the addition of a superposed course. The fact that these layers vary in thickness from a few inches to more than a foot may be traced usually to an effort on the part of the builders to maintain uniform levels—an unintentional irregularity in one layer would be corrected in placing the next above it. Mud plaster was ordinarily employed in smoothing the inner faces of these walls, but it is sometimes apparent that the freshly laid adobe was merely dampened with water and surfaced over, obliterating all traces of joints.

[1] Judd in Holmes Anniversary Volume, pp. 241–252. Washington, D. C., 1916.

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Working in this way, using their bare hands and with no tools other than crude bone and stone implements, the ancient artisans finally brought the new walls to a satisfactory height. A number of wooden beams were then laid a foot or more apart and across the shorter dimensions of the room; above and at right angles to them, smaller poles were placed, with willows or brush, grass and clay, in succession, completing the roof. The resulting cover was fairly tight, but extremely heavy; it successfully turned most of the winter's storms and required repair only two or three times a year, following the rainy seasons. Windows for the admission of light and air were unknown—aboriginal peoples seldom worried about ventilation or lack of it—and the only entrance to the room was a hole through the roof, an opening which was closed at times by a large, thin stone disk.[1]

The primitive masons of Parowan Valley had adapted to their needs the most available building material of their environment; they constructed houses which met their principal requirements and yet these houses had at least one defect which their builders seem not to have overcome. It is apparent that the roof beams did not protrude far beyond the outer surface of the sun-dried mud walls and consequently furnished scant protection for them. In seasons of rainfall, the water which accumulated upon the flat earthen roof either soaked through or ran off the edges and down the walls. In the latter case, the softened adobe would tend to give way under the weight of the heavy ceiling, causing the walls to collapse. It may safely be assumed that these dwellings were frequently destroyed in this manner, even though the opinion be based entirely upon circumstantial evidence, for many travelers in the Southwest have noticed the disintegration of modern adobe houses through the same agency.

A dwelling once destroyed was probably never wholly rebuilt, although its broken walls may have been partially utilized in the erection of a new structure. Lack of suitable tools made the mere task of removing such wreckage a tedious undertaking. To obviate the necessity for this and yet render the site suitable for a new

[1] The writer has been informed through several sources that the stone employed in making the round doors found so frequently among the Paragonah ruins could have come only from the West Mountains or Kane Spring Hills, 10 miles from the village. Stone of similar texture is unknown elsewhere in the vicinity; the difficulties of its transportation may be appreciated if the reader will recall that these old people had no beasts of burden and that many of the disks weigh as much as 75 and 80 pounds.

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habitation, the old walls were pulled down upon themselves, the mass brought to a uniform level, and erection of the substitute structure begun.

In a previous paper,[1] the present writer has briefly described the occurrence of superposed dwellings in mounds excavated at Beaver City, Utah. They, like the ones now under discussion, did not always possess the same floor area as the buildings they replaced. In some instances, one or more walls of the upper house coincided with those of the lower; in others, the long axis of the later dwelling lay at right angles to that of the earlier. The mere position of the new habitation seemingly did not influence its builders so much as the fact that necessity compelled its erection and that preference or social custom influenced its construction on the site of the one destroyed.

The occasional superposition of dwellings adds greatly to the interest of such structures as those disclosed by the 1917 excavations. A few of them, briefly described, may serve not only to indicate the general problems involved, but they may also contribute, in a greater or less degree, to an understanding of their primitive builders. Rooms 16-19, for example, occur in three distinct levels. Numbers 16 and 17 originally comprised a single room, but this was subsequently divided by a partition only half as thick as the main walls. Still later, both houses appear to have been abandoned, although Room 17 may have been temporarily occupied after construction of the neighboring house, number 18. A continuation of the floor level of this latter dwelling extended out over the razed walls of Room 16, 2 feet 9 inches above their inner base.

The length of the upper structure was nearly as great as that of Rooms 16 and 17 combined; the condition of its floor suggests occupancy during a considerable period. For some unknown reason, however, the walls of number 18 were later demolished and Room 19, a building only half as long, was erected above them. Seventeen inches of closely packed building material separated the two floors; the width of the structures was approximately the same, although the walls of the one did not rest directly upon those of the other.

The neighboring houses, numbers 8 to 12, furnish a similar example of superposition. Rooms 9 and 11 were built above the partially razed walls of Rooms 8, 10, and 12. Number 8 was constructed subsequently to Room 10, its floor being approximately 10 inches

[1] Proceedings of the Nineteenth International Congress of Americanists, pp. 119–124. Washington, D. C., 1917.

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above that of the latter; Room 12 was erected at the same time and on the same level as Room 10.

The walls of all three first-level houses were entirely of adobe, built up in layers, and smoothed or plastered on the inside. There is no means of determining the length of time each was inhabited, but, after a certain period of occupancy, they gave way to Rooms 9 and 11. Here again the walls of the upper structures do not coincide exactly with those of the lower; their orientation, nevertheless, remains practically the same. The floors in Rooms 9 and 11 had been constructed 3 feet 9 inches above that in number 10 and rested directly upon the irregular chunks of sun-dried adobe which formerly composed the walls of the lower room. Plate 3 illustrates the relationship between the outer west walls of Rooms 8 and 9 and shows the difference in their respective floor levels.

While considering this series of dwellings, attention should be called to certain peculiarities which have not been observed during the excavation of other similar houses. In the outer east wall of Room 8, averaging 36 inches above its base and 12 inches apart, was a row of small holes, marking the former position of as many wall pegs or hangers; additional pegs may have existed in the destroyed portion of the same wall. Holes of this sort in adobe dwellings are really unique; owing to their low position the use to which they were put must remain doubtful. A doorway, 17 inches wide and about 24 inches high, pierced the south wall of this room, it being the only lateral entrance yet observed among the prehistoric adobe dwellings of western Utah. So far as could be determined neither wood nor stone had been utilized in its frame. Room 9, directly above this house, was obviously entered through the customary roof opening.

At the south end of Room 10, in its opposite walls and 20 inches above the floor, were two series of four holes each. Those on the west side averaged 11 inches and those on the east 4 inches from each other. They marked the former position of horizontal poles, built into the walls at the time of their construction and probably formed a rude triangular bunk or shelf. This feature, also, is believed to be unique among prehistoric ruins north and west of the Rio Colorado and, if the conjecture be correct, it represents one of the few examples of built-in benches yet discovered among aboriginal dwellings of the Southwest. Similar series of pole rests were not detected in any of the other Paragonah structures.

Room 31, a third-level house, almost entirely destroyed by earlier excavations, was the only dwelling in the big mound whose floor

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consisted of a layer of coarse gravel and water-worn cobblestones, overlaid with adobe mud. Foundations of this character were invariably employed in the houses examined near Beaver City, Deseret and Hinckley, and they occurred frequently in those near Fillmore and Meadow, in Millard County. Excepting this course of small stones underneath the floor the house did not differ from the adobe dwellings described above.

It is to be regretted, of course, that the south one-third of the big mound had been completely razed before the recent expedition began its work. According to local reports, house walls were observed in this position of the elevation, and there are those who insist that circular rooms were also present. The number of these and the number of rectangular dwellings must always remain a matter of speculation; that they were many may be inferred from the total discovered in the remainder of the mound.

ASSOCIATED STRUCTURES

Most observers who have conducted investigations among the mounds of western Utah have noticed the occurrence of lesser structures in the areas immediately surrounding the adobe dwellings. Too little importance has been attached to these remains and their true import seems to have been generally overlooked.[1] The recent excavations at Paragonah disclosed houses of this type in large numbers and it is desired at this time to refer to them, collectively, in order that their real place in the community may be fully understood.[2]

It will be noticed that the more permanent habitations in the big mound are grouped to form, roughly, three sides of a square. The interior of this square was filled with accumulations of camp débris and wind-blown earth, averaging 6 feet in depth. The remains of temporary shelters were found without any semblance of order

[1] In the papers cited above, the present writer made no attempt to elaborate upon the court shelters or their obvious bearing upon the more permanent structures. There is evidence pointing to the fact that the former are older, structurally, than the latter.

[2] It should be stated that plate 1 shows but very few of the lesser structures exposed during the excavations of 1917. They were found in such unexpected numbers and so hopelessly interlocked that it was deemed inadvisable to interrupt the main work while each one was carefully uncovered. The chief characteristics of the type had been determined by the expeditions of 1915 and 1916; equally cautious dissection of the "big mound" did not appear commensurate with the time and expense involved.

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throughout these deposits. In one place, above fireplace L, seven distinct levels of occupancy were noted and the layers which supported them frequently merged one into another or disappeared entirely a short distance from the limits of the hut. Careful analysis of these levels and the material separating them leaves the impression that the lesser structures were so easily constructed that their abandonment was effected without great compunction, once their usefulness had ended.

The charred ends of upright posts show that a large proportion of these shelters were destroyed by fire; others may have become so filled with débris and dust that their builders found it desirable to select other quarters. In the latter case, the old hut would have been pulled down and its timbers utilized in the new structure, leaving the other materials which united in its construction as a further addition to the court deposits. All this is apparent from close examination of the remains, but many of the fireplaces, unlike those exposed by previous expeditions, exhibited no trace of a former covering and it may be that they were entirely unroofed. The huts varied somewhat in size and interior arrangement, but they were of the same general type and they served a common purpose.

In their simplest form these associated structures consisted of a roof supported by four uprights and they, in turn, surrounded a circular fireplace. The posts upheld crosspieces and against them, leaning outward toward the ground, was a succession of small poles. It seems most likely that grass and earth covered these sloping timbers, enclosing the room on at least three sides. That portion of the roof lying directly above the firepit was flat and constructed in much the same manner as that of an adobe dwelling, with possible provision for a smoke vent. In ruins of these huts chunks of burned clay, bearing impressions of the several materials which composed the roof, are almost always present upon the fireplace and within the area bordered by the uprights.

These lesser structures were really the living quarters of the ancient people, rooms in which their daily activities were performed. As each family possessed one or more adobe houses—places of protection or for the storage of semi-precious possessions—so, also, did each lay claim to at least one court shelter, an associated structure in which the family cooking was done, where garments and household utensils were prepared and where all those numerous small tasks that occupied the time even of primitive folk were performed. Some such shelters possessed a second fireplace; some a shallow, basin-like

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depression near the firepit in which clean sand was kept. Some huts were larger than others; some show longer occupancy; but none is without evidence of its true use, since small implements of bone and stone, charred corn and squash seeds, potsherds, split animal bones, and other camp-fire refuse, may always be found upon the smooth earthen floors and throughout the accumulations which separate the successive levels.

Excavation of the big mound disclosed ruins of still another type, structures not previously noted among the archeological remains of western Utah. Houses of this class possess certain features found, respectively, in the rectangular adobe dwellings and in the adjacent court shelters; they represent, perhaps, attempts to provide the roominess and stability of the former while utilizing methods peculiar to the latter. Rooms 20, 39, 40, 41, etc., are houses of the type under consideration and they are classed as secondary structures, since they apparently have a closer economic relationship to the shelters than to the heavy-walled buildings.

The first of these, although smaller than the others, may be considered typical of all. As discovered, it consisted only of a much-used floor whose outer limits were marked by a series of small post-holes. A rimmed fireplace, 13 inches in diameter and 6 inches deep, had been cut into the floor near the south wall. It would appear that this house had been erected some time subsequent to Kiva V, for example, since several inches of court accumulations, including two ill-defined levels of occupancy, separated the floors of the two structures.[1]

Room 39 was the largest house of this type, and it, in turn, had been built 14 inches above the floor of an earlier structure of the same kind, Room 40. A rimmed fireplace, 38 inches in diameter and 4 inches deep, occupied the middle of the room, and surrounding it, as in the smaller court shelters, were four large roof supports. The walls of this building were constructed of small upright posts, wattled with brush or willows and plastered with mud. More than 30 supports had been utilized in the west wall—the holes they once occupied were only a few inches apart and nearly every one was filled with decayed wood. In part of the east wall, against Room 35, horizontal willows had been bound to the uprights before they were

[1] Four feet four inches above number 20 and at right angles to its long axis was a third-level dwelling, Room 21. Its walls were entirely of adobe, constructed in the manner previously outlined; its floor was hard and smooth and rested directly upon the refuse and loose earth which covered Room 20.

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plastered; in another place it was determined with certainty that masses of plastic adobe had been forced between the posts and smoothed over so as to cover them.

Structures of this type, like the smaller shelters, were essentially living quarters or work rooms. Such use is indicated by the central fireplace—fireplaces were not present in any of the rectangular dwellings—and by the small objects found in the débris surrounding it. The two types were designed for similar purposes and, fundamentally, they were alike in construction. Only in form and size did they differ to any marked extent. The central roof of each was supported by four pillars; small poles made up the walls of both. In the smaller shelters these poles slanted downward and outward from crosspieces which rested upon the uprights; in the larger rooms they were set vertically and the wall supported the outer edges of a flat roof, laid in continuation of that directly above the fireplace. Structures of the first type were round or nearly so; those of the second class were quadrilateral.

CEREMONIAL ROOMS

Among the structures concealed by the big mound were three circular rooms and the remains of possibly two others. In form and in their position relative to the adjacent, rectangular dwellings these round rooms may be likened to the ceremonial chambers, or kivas, so inseparably connected with prehistoric Pueblo dwellings throughout the Southwest. They lack some of the structural details of the latter, but their use was so obviously the same that it seems permissible to employ the recognized Hopi term in referring to them. Such application of the word "kiva" has, in fact, already been made[1] by the present writer, in considering circular rooms observed previously at Paragonah and in other sections of western Utah.

In all distinctly Pueblo villages, both ancient and modern, the ceremonial room was the nucleus about which the life of the community revolved; the presence of more than one kiva denoted, merely, that the village was composed of several clans, each having its own unit organization and its own center of social and religious activity. In certain historical Pueblo settlements of New Mexico and Arizona, where Spanish influence was most pronounced, ceremonial rooms lost their original shape when their builders purposely hid them among dwellings of the house cluster, as a means of forestalling priestly opposition. In other existing communities the kiva

[1] American Anthropologist, Vol. 19, No. 1, Jan.–March, 1917.

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retained its circular form, remaining somewhat isolated and wholly or partly underground. Pueblo mythology prescribed a subterranean position, in respect to habitations, for purely ceremonial rooms and the Indians of to-day still adhere to tribal custom as far as possible, despite persistent efforts of their conquerors to substitute new religious precepts for the ancient beliefs.

The kivas in the big mound at Paragonah were circular in form; they were entered through a roof opening at a level corresponding to that of the court. This subterranean, or semi-subterranean position, however, appears to have been obtained in a manner somewhat different from that which governed the construction of such rooms in cliff-dwellings and exposed pueblos. In the two latter a location already lower than the houses was frequently chosen or a natural concavity was enlarged and deepened to meet requirements, or dwellings were even built up around the kiva, leaving it in a subjacent position. The circular rooms in the big mound, on the other hand, apparently were excavated from extensive piles of débris—accumulations which permitted the desired subterranean situation and yet left the kiva floors on practically the same level as those of the neighboring secular structures. Whether these piles were wholly artificial or whether they represented merely the usual court deposits could not be determined with certainty by the investigations of 1917. The important fact to be considered is that circular structures have been found in this section of the west and that they were given an underground position in respect to the adobe habitations.

Architecturally, the Paragonah kivas were constructed in a very simple manner. A hole of the desired depth and diameter was excavated from accumulations of earth and camp-fire débris; its walls and floor were then surfaced with mud and allowed to dry. This method appears in sharp contrast to that employed in the adjacent houses where superposed courses were laid with considerable care. In most cliff villages of the Southwest those rooms designed primarily for ceremonial purposes represent the highest local development in masonry, but at Paragonah the contrary is true. The mud plaster was spread directly upon the face of the cut and, from the outside, there is nothing which would suggest the presence of a wall. A roof of the type previously described covered the room and the customary hatchway served as the sole means of entrance. In none of these chambers was anything found which would correspond to the *sipapu,* the fire screen or the wall recesses in prehistoric kivas throughout the San Juan drainage, for example.

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Among the circular rooms in the big mound, number 1 is especially noteworthy. As in certain habitations, it illustrates the readiness with which its ancient builders abandoned one building in favor of another or the apparent ease with which they utilized the remains of one structure in erecting a second. Kiva I may be considered as merely the contraction of a larger, similar room whose floor and north wall were retained as part of the later building; it seems a confession on the part of its builders that they lacked the skill necessary to construct successfully so large a structure as that which it replaced. When exposed the walls of the smaller room were practically intact; those of the larger had disappeared except on the north and west sides. The precursor of number 1 had been excavated from the loose court deposits and its walls consisted only of thick coats of mud spread directly upon the ash-bearing earth; the smaller room had been built within the larger, its north wall coinciding with that of the latter and its other sides being formed by the débris thrown upon the floor and within the razed walls of the earlier structure. A rimmed fire-place 26 inches in diameter and 3 inches deep occupied the middle of the floor.[1]

Kivas II and III are really counterparts of number I, although differing somewhat in size. The third of these, unfortunately mutilated during the removal of the south end of the mound, had also undergone repairs, a second floor having been laid 2 inches above the first. The room is still further unique in possessing an extra fireplace, adjoining and but slightly smaller than the usual central hearth. Against the southwest wall was a posthole which held a support for one of the heavy roof beams, a feature also noted in kivas exposed during the expeditions of 1915 and 1916.

The curved wall fragments of possibly two additional kivas were observed, respectively, within Room 35 and in the open court east of Rooms 8 to 12. The first of these measured only a few feet in length; its floor, although broken and so near the surface as to render its exposure difficult, was traced beyond the razed east wall of Room 35. This room was circular in form and there seems but little doubt that it was used chiefly for ceremonial purposes.[2] Greater uncer-

[1] In the court accumulations between Kiva I and Rooms 8 and 32 several levels of occupancy, from 2 to 10 inches in thickness, were noted. Each of these showed fireplaces and the remains of shelters associated with the neighboring rectangular habitations, but the ground plan does not presume to delineate all of those discovered.

[2] The necklace of bone pendants and "gaming counters" noted on page 16 was found on the floor of this room.

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tainty exists regarding the other room, which has been marked Kiva V. Its floor lay in that portion of the mound where superposed levels of occupancy were most numerous, and it may be that the room was no more than an enlarged shelter. Fragments of curved adobe walls remained on the eastern side and these, if continued, would have circled a central fireplace about which four large pillars formerly stood. It is the presence of these surrounding posts that suggests the possibility of this having been one of the numerous associated structures, but kivas with roofs supported by uprights were noted, also, during preceding expeditions and in so large a room pillars would have been absolutely necessary. Curved adobe walls, on the other hand, have not yet been observed among the remains of purely court shelters.

MINOR ANTIQUITIES

In reviewing the minor antiquities exposed during the excavation of the "big mound" the observer will, first of all, be attracted by the preponderance of bone objects. Bone implements and ornaments of many shapes and sizes, and in various degrees of completion, were found in unexpected numbers; in addition, there were large quantities of mere refuse—bones split to facilitate the extraction of marrow, charred bones, and those apparently tossed carelessly to one side. Among this mass of worked and unworked material there may be recognized skeletal fragments of such animals as the deer, antelope, mountain sheep, bear, and various smaller mammals. There are also a few fragments of heavy antler which appear to be elk and several pieces of large, worked bone that have been tentatively identified as those of the buffalo. All of these, taken together, indicate that the ancient house builders were persistent hunters and that the animals killed not only contributed largely to their food supply, but formed, also, the chief source of one of the materials most essential to the economic pursuits of the community.

Awls are especially numerous and vary in size from the small, sharpened metapodial of the deer to those cut from the full length of the canon bone. Most of them are merely ground and sharpened fragments, but several exhibit a high degree of specialization and are really pleasing examples of aboriginal art. A few were perforated at the butt end for the attachment of a cord and still others, as in plate 11, were decorated with incised lines. Some of the awls are long and slender, like needles; others are heavy, blunt, and

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frequently chipped at the end as though employed as punches in flaking arrow points, etc. But all of them, crude and finely worked together, were utilized in the daily activities of their owners, in weaving baskets, in making skin garments, and in numerous lesser tasks for which they were not, perhaps, especially intended.

Closely allied to the bone awls is rather an extensive group of implements shaped from antler. These include chiefly punches and flaking implements, but there is, also, a remarkable collection of wedges, three of which are figured in plate 12. Among the antler fragments, as with the bones, there are specimens that accurately illustrate the manner in which they were prepared for use—specimens which include selected though unworked tynes, those partially or completely sawed with flakes of flint and cut pieces that show various stages in the grinding process by which the objects were brought to completion.

Next to the awls, numerically, is a large series of more or less carefully shaped objects, some of which are shown in plate 13. Most, perhaps all, of these were employed as dice or counters in various games and yet some of them were unquestionably adaptable to other purposes. The series is truly noteworthy, both in point of number and in the workmanship of many of the specimens. These arrange themselves naturally into groups, according to the character of the finished object—groups which range from the rudely chipped counter to those neatly polished, perforated, and ornamented by drilled dots or incised lines. A large percentage of these, crude and highly worked alike, bear traces of red paint on the under or concave side and it may be that each one was so marked when in use. That all of these, especially those which are perforated, were not employed exclusively in games is indicated by the recovery of 10 charred "counters" together with 14 bone pendants—the whole probably forming a necklace—from the ashes of a fireplace in Kiva IV.

Pendants and broken counters reworked to form like ornaments, beads of various sizes, small gaming disks or dice and even finger rings are among the bone objects collected. The latter, especially, will bear brief consideration, since the specimens recovered illustrate each stage in ring manufacture. A section of predetermined width was sawed from a large bone, as indicated in plate 11; this piece, in turn, was ground down and polished by rubbing on sandstone and perhaps later carved or incised with lines. The hollow character

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of certain mammal bones probably suggested this use, and primitive delight in personal adornment quickly led to the adoption of the new ornament. Complete specimens were fewer in number than the fragments recovered, but all are highly interesting and most of them speak well for the artistic ability of their makers.

Objects of bone collected by the 1917 expedition were important both in quantity and in quality of workmanship. The stone artifacts, on the other hand, although numerous, embraced but few types and these exhibit no marked deviation from similar imple-

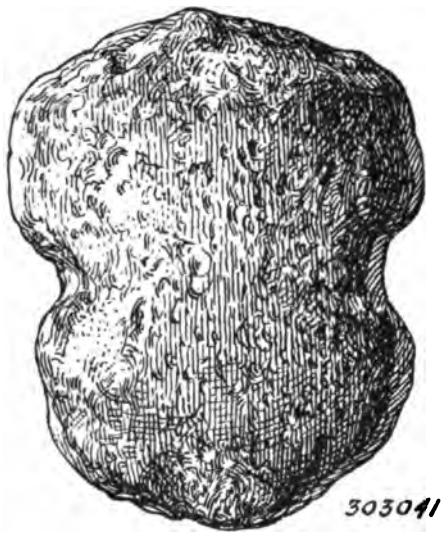

FIG. 1.

ments, widely distributed throughout the Southwest. As might be expected, hammer stones and mullers predominate, but there are also large numbers of rubbing and polishing stones, discoidal jar covers, gaming balls,[1] etc.

Grooved axes and mauls seem to have been wholly unknown to the inhabitants of the adobe dwellings. After three summers' work among the ruins of western Utah the writer has found but one implement, figure 1, which even approaches an ax in form and this is a crude basalt hammer, notched for hafting, and probably made

[1] Small stone balls, usually encrusted with a softer material, were employed by various southwestern tribes in games for both adults and children. The recent expedition collected 75 of these and, in addition, two specimens of adobe. To one of the latter was still attached a fragment of its original clay covering.

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from a fragment of a broken muller. The absence of these common North American implements is, in itself, significant; especially so, since suitable stone was not entirely lacking. It means either that the aborigines had not yet discovered the feasibility of stone axes—which is almost unbelievable, considering their advancement in other lines—or that they were still content to use other weapons and to employ fire in felling the larger timbers utilized in the construction of their dwellings and associated structures.

Most of the metates, or stones on which corn, etc., was crushed, are of a type peculiar to western Utah. They consist of fairly large basaltic boulders and are generally but little worked, excepting the upper surface. The exceptional feature of these metates is the small, secondary area adjoining the grinding surface and at that end of the stone which would have been elevated while in use. It is usually, though not always, concave, but whether it was designed as a rest for the muller or intended primarily as a container for ground meal is still problematical. It would have answered either purpose, although not absolutely essential to the efficient use of the metate. The small basin does not customarily appear on stone mills found elsewhere.[1]

Traces of red paint on both metates and mullers illustrate the readiness with which primitive man employed his various utensils in the task at hand. Red ochre was collected along the foothills, brought to the village and pulverized for use in bodily adornment and the ornamentation of pottery, etc. The frequency with which paint-covered mullers are found indicates that the quantity of natural pigment employed by the ancient people of Paragonah was not inconsiderable. It is not apparent that they employed special mortars and pestles in the preparation of paints as was done at Zuñi and elsewhere.

The pottery exposed by the expedition of 1917 is much the same as that found during the excavations of the two preceding years. A majority of the shards recovered are of plain ware; corrugated vessels were evidently less common than in ruins farther north. These fragments, however, taken with those which bear traces of ornamentation, are sufficient to indicate the development of the ceramic art among these house builders and to establish a cultural affinity between them and the ancient people south and east of the

[1] The writer's attention has been called to a similar metate discovered on the outskirts of Moab in Grand County, Utah, by Dr. A. V. Kidder of Harvard University.

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Rio Colorado. Decorated jars and ollas were obviously rare, but bowls carrying the customary black decorations over a gray interior wash were plentiful. On these latter are figured many of the geometric patterns common to the northern part of the prehistoric Pueblo area; only one shard has been noted which carries a representation of an animal. However instructive a comparison of the earthenware vessels from the two regions might be it again seems advisable merely to affirm the similarity in design and leave for a future paper detailed consideration of the western Utah pottery.

An examination of these Paragonah fragments discloses one peculiarity of ornamentation which is too often repeated to suggest mere accident. This is the interlineal use of red paint, superficially applied. The black decorations were painted directly upon the kaolin wash and were permanently fixed when the specimen was fired. Some of these, however, especially bowls with encircling bands, were further ornamented with red ochre and this almost without exception was drawn between the black lines some time after the vessel had been removed from the kiln. The red paint, not being permanent, is readily removed by rubbing, but its decorative effect remains unquestioned. Plain-ware bowls and jars and even coiled ollas were sometimes covered on the outside with a thin coat of this same pigment, producing results which, in general appearance, approach the unpainted red ware of the Little Colorado drainage. Judging solely from the shards collected, earthenware vessels decorated with red before firing were extremely rare in the Paragonah region.

Besides the usual objects of bone, stone, and pottery, a number of less common artifacts were recovered from the big mound. Perhaps the most interesting of these is a tubular stone pipe, figured in plate 15. The original, now in the University of Utah Museum, is of agalmatolite, or possibly serpentine. It is of the well-known California type and undoubtedly reached the Parowan Valley through inter-tribal commerce.[1] The typical Utah pipe—if a type can be determined from incomplete investigations—is of clay and varies between numbers 303177 and 303179, plate 15. Short tubular pipes with flaring lips have been found in widely separated localities; clay

[1] That materials and artifacts prized by primitive peoples were frequently transported almost incredible distances is a fact well known to anthropologists. Several dozen beads made from Pacific coast shells (*Olivella biplicata,* Sby. and *Olivella dama,* Mawe), were found in the "big mound" and indicate that the difficulties of a foot journey across the Nevada and California deserts were not insurmountable.

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pipes[1] with bowls inclined upward at the end of the stem, or lying wholly within it, are not uncommon and these, too, are widely distributed throughout the region of the adobe houses. Stone pipes of this same general type, but much heavier than those of clay have been found in other western Utah mounds, although none were discovered by the recent expedition.

Among the lesser antiquities recovered are certain seeds and pieces of basketry—perishable articles whose charred condition is alone responsible for the their present degree of preservation. The first of these includes grass and squash seeds, corn, beans, and piñon nuts—foodstuffs which indicate that the old house builders knew something of agriculture and did not rely wholly upon the skill of their hunters. The basketry, one fragment of which is illustrated in plate 12, is of the coiled variety so common among the ancient cliff-dwellers and represents a high quality of workmanship. Baskets were unquestionably in constant use by the primitive folk of Parowan Valley and far more numerous than their occasional remains would lead one to believe.[2]

Something has been said above of the use as paint of clay stained with oxide of iron. Pieces of yellow ochre were also found, but these were undoubtedly employed chiefly for bodily adornment. So far as known, potsherds bearing indications of yellow decoration have not yet been discovered in western Utah mounds. Small masses of kaolin are occasionally recovered from these ruins—masses that furnished the whitish coat with which the vessels were surfaced, previous to the application of decorative designs. Some of them, however, are so nicely shaped and of such definite form (pl. 12, a) as to suggest their possible use in certain kiva ceremonies.[3] A con-

[1] The small effigy pipe, number 301976, plate 15, is the only one of its kind known to have been found in a Utah mound. The original, now in the University of Utah Museum, is of clay and probably represents a ground squirrel; its stem had been broken one-half inch from the bowl, but was subsequently ground down for continued use.

[2] Rumor has it that pieces of charred cotton cloth have been found during previous excavations at Paragonah, but no traces of such fabric were discovered by the 1917 party.

[3] A story often repeated at Paragonah relates that the walls in one of the adobe dwellings previously exposed were painted white and, over this, figures in red, green, and yellow had been drawn. The excavation of many similar ruins, both at Paragonah and elsewhere, has failed to disclose any trace of like ornamentation, although walls are frequently observed whose faces are covered with a thin coat of alkaline salts, deposited by the network of rootlets which follow down the hard wall surface and tend to separate it from the softer accumulations of débris and wind-blown earth. In the opinion of the writer,

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siderable vein of this material is said to exist in the Escalante Desert, northwest of Rush Lake and about 20 miles west of Paragonah.

Two or three small masses of sulphur were also found among the house remains. None of these, however, bears any mark which would suggest that the mineral had been intended for, or put to, a definite use. It would appear most likely that the original collector had been attracted merely by the color of the stone and carried it to the village under the assumption that it could be ground into paint.

A few fragments of ore-bearing rock were recovered at the same time. These were utilized solely as hammer-stones and are not, as might be inferred, evidence that the ancient house builders possessed knowledge of smelting processes. Implements and ornaments of metal are entirely unknown among the Utah ruins—persistent local contentions to the contrary—and they have never been discovered in pre-Spanish villages in any other section of the Southwest, excepting, of course, those few southern Arizona and New Mexico localities that had established inter-tribal communication with the peoples of central Mexico. The highly colored stories so widely circulated throughout Utah regarding the discovery of gold, silver, and iron artifacts in purely prehistoric ruins are deliberate fabrications whose chief purpose seems to be the willful deception of the most credulous. Tales of this sort have frequently acted as a spur to those seeking supposed fabulous riches and are directly responsible for the wanton destruction of many aboriginal remains whose historical value cannot be over estimated.

SUMMARY

Certainly the chief result of the recent Smithsonian Institution-University of Utah expedition was the successful exposure of some 40 odd houses and numerous associated structures, comprising the greater part of an extensive prehistoric village. These were of entirely distinct types, grouped to form a single compact community; their apparently studied arrangement and the obvious relationship between them and the nearby, circular rooms is evidence that definite social and religious principles governed the daily life of their occupants. The more permanent dwellings were of adobe, built up usually in courses and smoothed or plastered on the inside; the secondary buildings may be described as brush shelters—the living quarters of the villagers—in which were performed most of their

these salty deposits were mistaken for "whitewash"; the "paintings" may be wholly or in part the product of the imagination.

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domestic activities. The shelters seemingly were erected without serious consideration of their possible interference with the general plan of the village; they were easily constructed and the site chosen for each appears to have been the least obstructed space nearest the home of the prospective builders. Huts of this type, together with the adobe houses, acted as natural barriers that caught and held the wind-blown sand and earth as it swept across the treeless foothills and settled in and among the dwellings, adding materially to the size of the mound. Not all of the exposed dwellings were inhabited simultaneously and it is highly probable that many decades elapsed between the occupation and abandonment of the site.

Ceremonial chambers adjacent to the secular structures suggest that at least three clans had united in the establishment of the village. In form and their obvious connection with the neighboring habitations these circular rooms resemble the kivas in cliff-dwellings and historical Pueblo villages. Although certain structural details commonly identified with the latter are absent in the Paragonah kivas, but little doubt remains that they served similar purposes and exerted equally important influences upon their respective builders.

Large numbers of artifacts were recovered from the refuse heaps which filled the open spaces between the houses. Most of these are of bone and stone, but charred fragments of more perishable materials were also found, and all of them, taken together, indicate that the ancient artisans possessed considerable ingenuity and attained creditable results with their crude implements. Among the objects collected are many shards of earthenware vessels decorated with geometric figures of a type common to prehistoric communities south and east of the Rio Colorado. Inasmuch as decorative motives did not change readily among the ancient house builders of the Southwest this similarity in pottery design is noteworthy.

Not only the character and ornamentation of certain lesser antiquities, but also the structural peculiarities of the rectangular dwellings and their general relationship to each other confirm the opinion that a marked cultural affinity existed between the ancient people of Parowan Valley and those inhabiting the semi-arid regions east of Navaho Mountain. Just how extensive and far-reaching this may be can be determined only by additional investigations—researches that shall have for their prime motive the tracing of the ancient culture so characteristic of western Utah. Once these limits are ascertained the problem of the Utah mounds will have been solved and the builders of the adobe dwellings will have found their rightful place in the story of our prehistoric Southwest.

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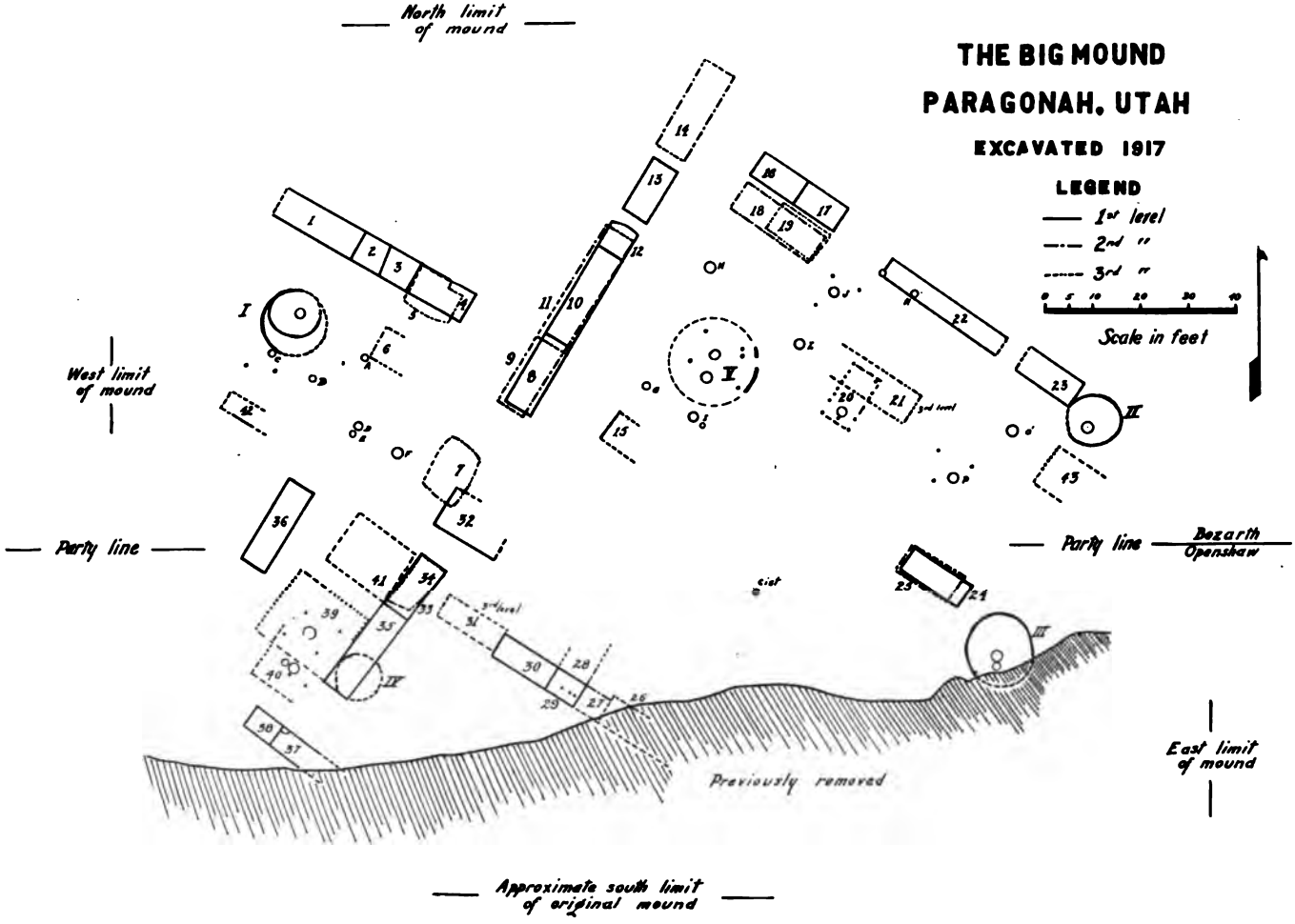

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Trenching in search of rooms on the northwest quarter of the mound. View from the north.

Excavated northwest quarter of the big mound with Room 14 in the foreground. Compare view above.

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Outer west walls of Rooms 8 and 9, from the southwest. The layer of broken adobe shown in the middle of the photograph rests upon loose earth and débris and forms a foundation for the west wall of Room 9.

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Looking northwest, across Rooms 8-12. The depth of the court accumulations is indicated by the workmen who are standing near Fireplace I. West Mountains and Little Salt Lake appear in the distance.

The two fireplaces and three of the charred posts of Kiva V, in the foreground. Note the courses in the outer east wall of Room 8. View from the east.

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Decayed remains of large upright cedar posts which formed the west wall of Room 43.

Superposed adobe dwellings, 16-19, with the floors of Rooms 18 and 19 plainly visible. The men are at work in the central court, near Kiva V.

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Kiva III from the southwest; the two central fireplaces appear indistinctly in the foreground; numerous squirrel burrows pierce the walls.

Looking down into Kiva II from above Fireplace O', with Room 23 showing at the left.

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Kiva I from the southwest corner of Room 6, shown at the lower right. The posthole in the middle foreground was the only one found near Fireplace A; Fireplace B appears at the left.

Kiva I from the north wall of Room 2, shown at the lower right; Fireplace B at the left of the braces which support the east wall of the ceremonial room.

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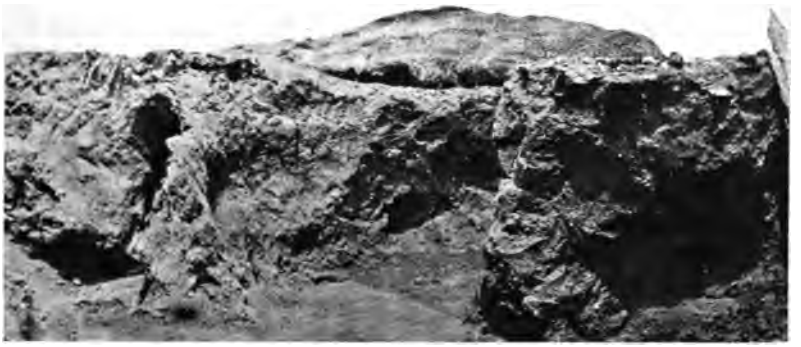

Looking into Kiva I from a point near Fireplace C, but within the standing south wall of the larger ceremonial chamber first constructed. Part of the latter appears at the left.

Rounded masses of adobe wall material under the floor of Room 19. It will be noted that these are not all of the same shape or thickness.

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Room 39 from the north wall of Room 35, showing the central fireplace and sticks marking the position of two of the four surrounding pillars. The pegs beyond occupy postholes along the west wall.

Floor of Room 39, as seen from the south. In the foreground, the wall of an earlier dwelling, razed to the floor level of the later house. Pegs mark the position of upright posts.

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Looking northeast across the central court, from Room 15; wall fragments and charred uprights of Kiva V in the middle foreground; south wall of Room 19 stands at the left. Various levels of occupancy are indicated.

View from the southeast, showing north limit of the excavations which previously reduced the south end of the big mound.

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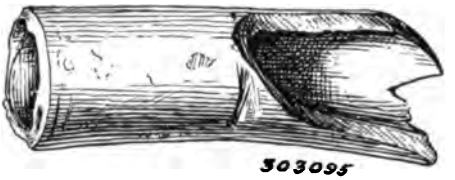

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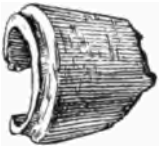

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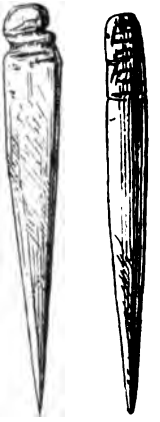

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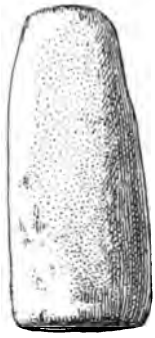

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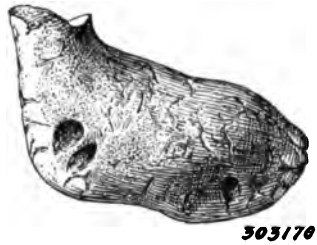

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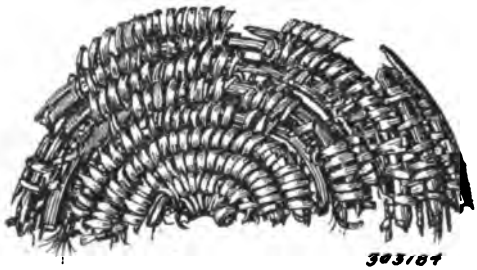

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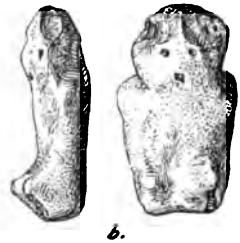

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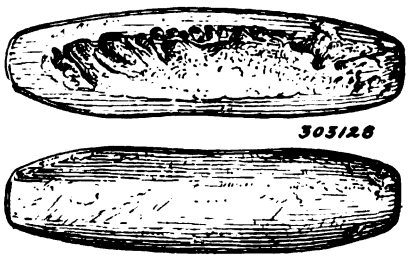

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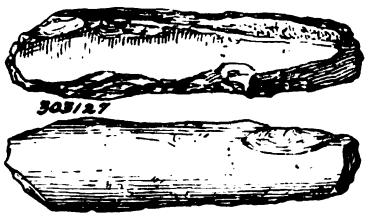

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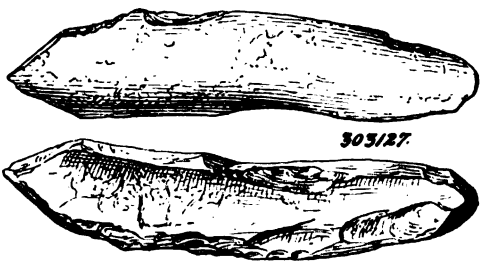

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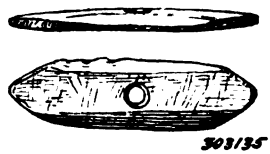

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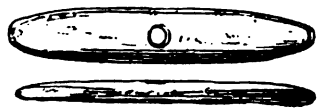

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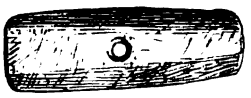

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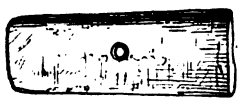

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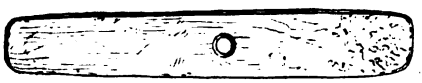

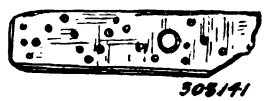

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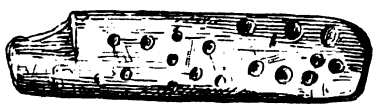

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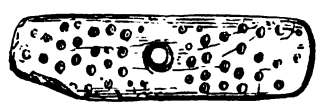

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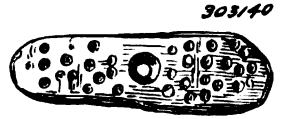

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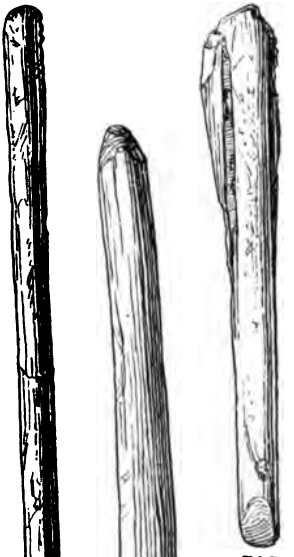

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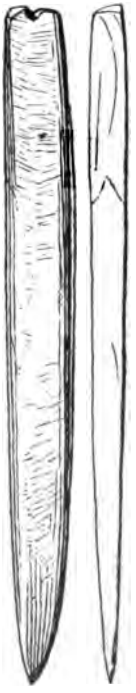

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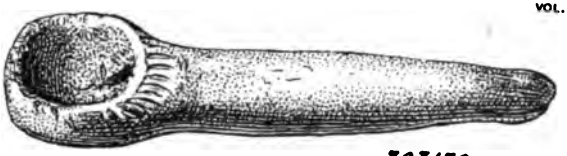

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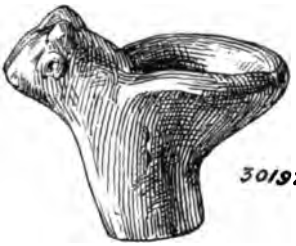

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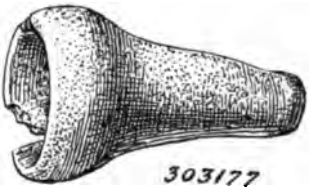

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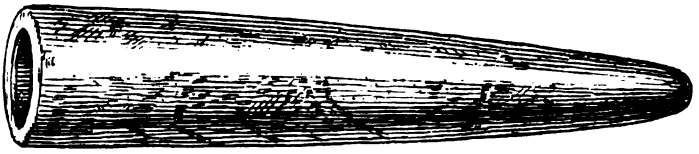

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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 72, NUMBER 1

EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1919

(PUBLICATION 2581)

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Cliffs of Mt. Outram (10,670')

Glacier River

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Southeast Lyell Glacier

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1919

INTRODUCTION

An important phase of the Institution's work, in carrying out one of its fundamental purposes, the "increase of knowledge," is the scientific exploration by members of the staff of regions in this country and abroad previously imperfectly known to science. The more important of these field researches carried on during 1919 are here described briefly, for the most part by the explorers themselves. Naturally the great war held in abeyance a number of proposed expeditions, some of which it has since been possible to send out on the resumption of a peace status.

GEOLOGICAL EXPLORATION IN THE CANADIAN ROCKIES

Geological explorations were continued in the Canadian Rocky Mountains during the field season of 1919 with two objects in view: (1) The discovery of an unmetamorphosed, undisturbed section of the Upper Cambrian formations north of the Canadian Pacific Railway; and (2) the collection of fossils to determine the various formations and to correlate them with the Upper Cambrian formations elsewhere.

The party going from Washington consisted of Dr. and Mrs. Charles D. Walcott and Arthur Brown, who has accompanied them for a number of years.

Early in July an attempt was made to reach Ghost River northeast of Banff, Alberta, but this failed owing to the extensive outbreak of forest fires in that region.

In August the party proceeded north from Lake Louise over Bow Pass down the Mistaya Creek to the Saskatchewan River, and thence up to the head-waters of the Middle Fork in the area about Glacier Lake, where a wonderfully well preserved Upper Cambrian series of rocks was found that had been cut across in pre-glacial time by a deep east-and-west canyon valley, at the head of which were two beautiful glaciers, which are illustrated by the panoramic view figure 1 (Frontispiece), and more in detail by figures 5, 7, 8, 9, and 10.

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The character of the mountains about the head-waters of the Middle Fork of the Saskatchewan is illustrated by figure 2, where a glacial stream flows out through a deeply eroded valley with high ridges and peaks rising in steep slopes and cliffs. The position of the camp in Glacier Lake canyon is shown in figure 3, and the outlook to the west toward the glacier from the camp by figure 5, and to the

FIG. 2.—View looking up the Middle Fork (Howse River) of the Saskatchewan River to Howse Pass (5,000′) on the Continental Divide.

In the distance beyond Howse Pass the peaks of the Van Horne Range and Mount Vaux of the Ottertail Range, and on the right and above the Pass Mount Conway, and to the extreme right the eastern ridge of Mount Outram.

Locality.—View taken from the upper slope of Survey Peak above Glacier Lake, about 48 miles (76.8 km.) northwest of Lake Louise station on the Canadian Pacific Railroad, Alberta, Canada.

Photograph by Mr. and Mrs. C. D. Walcott, 1919.

east by figure 4, where the dark massive bulk of Mount Murchison rises in cliffs above the canyon of the Mistaya River along which the trail from Bow Pass descends.

The measured geological section begins at the foot of the ridge at the extreme left of figure 1, and was measured in the cliffs and slopes, and thus carried to the side of the Mons glacier shown in

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the central portion of figure 1, the upper limit of the section being above the narrow vertical F-shaped snow bank directly over the glacier. The evenly bedded rocks sloped at an angle of from 10 to 20 degrees, westward, which accounts for the great thickness measured, although the elevation above the canyon bed was not more than 3,500 feet.

FIG. 3.—Walcott camp located in the brush beside Glacier River, 1 mile (1.6 km.) below the foot of Southeast Lyell Gacier, which is shown more distinctly in figure 5. Photograph by Mrs. C. D. Walcott, 1919.

The glaciers.—The Southeast Lyell Glacier is beautifully shown in figure 1, and also in figure 5, and more in detail by figure 6, where it is cascading over a high cliff. Figure 1 is a profile view of Lyell Glacier from the Continental Divide on the right to where it abuts against the low cliff on the left. In figure 6 the foot of the glacier is shown, along with large amounts of débris forming the terminal moraine, also the dark mass of broken rock and débris carried on the back of the glacier, which is shown in figures 1 and 6.

A portion of the great snow field from which both Lyell and Mons glaciers flow is shown on the slope of Mons Peak on the left side of figure 5. This snow field extends back of Division Mountain,

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FIG. 4.—Mount Murchison as seen from camp on Glacier River, from a point one mile (1.6 km.) above the head of Glacier Lake.
Locality.—The view is from a point about 47 miles (75.2 km.) northwest of Lake Louise station, on the Canadian Pacific Railroad, Alberta, Canada.
Photograph by Mrs. C. D. Walcott.

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FIG. 5.—View looking westward from Walcott camp up Glacier Lake Valley to Southeast Lyell Glacier and Division Mountain, which is on the Continental Divide. The great snow field extends around back of Division Mountain, connecting the névé of Lyell and Mons Glaciers.

Locality.—The view is from back of the Walcott camp at a point about 48 miles (76.8 km.) northwest of Lake Louise station, on the Canadian Pacific Railroad, Alberta, Canada.

Photograph by Mrs. C. D. Walcott, 1919.

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FIG. 6.—View of Southeast Lyell Glacier from the Glacier Lake Canyon bottom below the foot of the glacier. *Locality.*—The view is taken from a point about 50 miles (80 km.) northwest of Lake Louise station, on the Canadian Pacific Railroad, Alberta, Canada.
Photograph by Mr. and Mrs. C. D. Walcott, 1919.

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dividing Mons and Lyell glaciers, and continues along the Continental Divide for many miles, contributing to glaciers both on the Pacific and Eastern sides of the Rockies.

FIG. 7.—View of the ice fall of Southeast Lyell Glacier, taken from the surface of the glacier below the fall. The locality is the same as for figure 6. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

Mons Glacier is named from Mons Peak, shown in figures 5 and 8. It flows over the high cliffs (see fig. 8), and creeping down the

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slope, spreads out in a fan-like form toward its lower end. Seen in profile, this portion of the glacier resembles a great animal sliding down the sides of the broad canyon. The foot of Mons Glacier with the stream flowing from beneath it is illustrated by figure 11.

FIG. 8.—View of Mons Peak (10,114′) and the upper snow fields of Mons Glacier, also the cascade of the glacier over the cliffs below. The summit of the peak is more than 2 miles (3.2 km.) back of the glacier, the intervening space being occupied by a great snow field from which the glacier flows. The locality is about the same as for figures 2 and 5. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

These views (figs. 5, 8, 9, 10 and 11) illustrate a glacier from its névé at the base of Mons Peak (fig. 8) to its foot (fig. 11), where the retreating ice is making its stand against the force of the summer sun and wind.

Geological section.—The geological section, which is beautifully exposed in the mountain ridge of figure 1, is of such interest that it is included in this brief account of the exploration in the vicinity of

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FIG. 9.—View of Mons Glacier from the lower end of the east moraine of the Southeast Lyell Glacier. This view shows the crevassing and terracing of the ice where it goes over the cliff; also its extension and lateral crevassing where it abuts against the rocks below. The crevassing of the Lyell Glacier is also beautifully shown as well as the broken rock and débris on the ice, which is also finely shown in the panoramic view, figure 1. The locality is about the same as for figure 6. Photograph by Mr. C. D. Walcott, 1919.

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FIG. 10.—Profile view of Mons Glacier taken from the surface of the lower portion of Southeast Lyell Glacier. The glacier looks like a gigantic animal sprawling down the slope of the mountain. The locality is about the same as for figure 6. Photograph by Mr. C. D. Walcott, 1919.

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FIG. 11.—Foot of Mons Glacier from canyon down through which the glacier formerly extended to unite with the south end of Northeast Lyell Glacier. The locality is about the same as for figure 6. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

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FIG. 12.—Mount Forbes as seen from the north, looking across the lower end of Glacier Lake Canyon Valley. The locality is the same as for figure 2, from the upper slope of Survey Peak above Glacier Lake, about 48 miles (76.8 km.) northwest of Lake Louise station, on the Canadian Pacific Railroad, Alberta, Canada. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

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FIG. 13.—Leaving Glacier Lake camp with the camp outfit and specimens on the pack horses, ready for the four days' trip to the railway. Photograph by Mrs. C. D. Walcott, 1919.

FIG. 14.—Mount Ball (10,825') on the Continental Divide from the southwest slope of the Sawback Range, looking across Bow Valley.
Locality.—About 17 miles (27.2 km.) west of Banff, Alberta, Canada. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

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Glacier Lake. The rocks exposed in the highest cliffs of Mount Forbes and Mons Peak belong to the great Carboniferous system of rocks of this region. Below this series occur the Devonian rocks, the snow-capped cliffs shown in figure 1 above Mons Glacier, forming a belt 1,000 feet or more in thickness, and below these are the strata of the Sarbach formation of the Ordovician system, and

FIG. 15.—Mountain sheep in game sanctuary, Rocky Mountains Park, Alberta, Canada. Photograph by Mr. and Mrs. C. D. Walcott, 1919.

beneath the Sarbach the five formations assigned to the Upper Cambrian series. Attention should be called here to Mount Murchison, figure 4, where there is almost the same series as that exposed in the cliffs on the long mountain slopes of figure 1. To the left of Mount Murchison in figure 4 there is a low ridge formed of strata of Middle Cambrian age which passes beneath the rocks of Mount Murchison.

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FIG. 16.—Cirkut camera in use on the south slope of the Sawback Range, looking across Bow Valley, Alberta, Canada. Photograph by Mrs. C. D. Walcott, 1919.

GLACIER LAKE SECTION, ALBERTA

	Formation	No.	Stratum	Thickness feet
Ordovician	Sarbach. (1120 feet) (341.3 meters).	1	Thin-bedded gray limestone.	700 (est.)
		2	Argillaceous shale.	420
Upper Cambrian	Mons. (1480 feet) (467.2 meters)	1a	Calcareous shale and limestone.	235
		1b	Massive bedded gray limestone.	740
		1c	Limestone and shale.	320
		1d	Oolitic limestone.	185
	Lyell. (1700 feet) (518.9 meters).	1a	Massive bedded gray limestones.	1,270
		1b, 1c, 1d	Light gray thick-bedded limestone.	430
Upper Cambrian	Sullivan. (1440 feet) (464.3 meters).	1a	Compact gray limestone.	325
		1b	Shale with interbedded layers of limestone.	975
		1c, 1d	Oolitic limestone and shales.	140
	Arctomys. (1386 feet) (422.4 meters).	1a	Laminated limestones.	520
		1b	Purple, green, and gray shale with layers of laminated limestone.	866
	Murchison. (220 + feet) (67 meters).	1	Gray and bluish-black limestone, Base concealed.	220+

Total thickness Cambrian strata.....6,226

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On returning, a camp was made in the Bow Valley below Lake Louise at the foot of the Sawback Range, where a brief examination was made of the up-turned Carboniferous, Devonian, and Cambrian formations, and fossils were collected, many of which are identical with those found in the Glacier Lake section. One of the views across Bow Valley is of Mount Ball (fig. 14), which is one of the massive peaks on the Continental Divide where the Middle Cambrian rocks have a great development.

The preliminary study of the fossils in the several formations correlates them with the Upper Cambrian formations of Wisconsin and Minnesota and the Upper Cambrian section in southern Idaho, and to a more limited extent with that of the central belt of Pennsylvania.

GEOLOGICAL AND PALEONTOLOGICAL EXPLORATIONS AND RESEARCHES

Field-work in the Department of Geology has been considerably restricted by prevailing conditions during the season of 1919. Research work has, however, continued on the collections accumulated either in years past or obtained through gift or purchase in more recent times.

One of the most interesting acquisitions to the geological collections during the year 1919, was some 15 kilograms of the meteoric stone which fell at Cumberland Falls, Kentucky, in April of this year. The stone, which proved to be a coarse breccia of enstatite fragments and a dark chondritic stone, has been studied by Dr. Merrill, and a paper giving his results is now in press.

Owing to the fact that the division of Mineralogy has been without a head for two years, a large amount of work upon the collections has been necessary and hence only a limited amount of field and research work was possible. On his own initiative, two field trips were undertaken by Assistant Curator Foshag, one to the mica mines about Amelia, Virginia, where a considerable amount of study material was collected. This included a large number of specimens of the rare mineral microlite and an exhibition specimen of manganotantalite, the latter species not before represented in the Museum's exhibition series. The old iron mine at Brewster, N. Y., was also visited and some material for study collected. The work of the division in the Museum's laboratory consisted in an investigation of the hydrotalcite minerals, resulting in the establishment of the true chemical nature of this group. Shorter researches on miscellaneous minerals

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were also carried on. Work is now under way on the study of the mineralogy of serpentine and its relation to the chlorite group, and also the correlation of the chemical composition and the optical properties of rhodonite, the latter in collaboration with Dr. E. S. Larsen of the U. S. Geological Survey.

In October various localities in Connecticut were visited by Assistant Curator Earl V. Shannon, including the vicinity of Long Hill in Trumbull, where tungsten has been mined in years past. Extensive collections comprising much interesting material were

FIG. 17.—Transporting fossil specimens in Southeastern Indiana. Photograph by Bassler.

obtained which will be studied and described. The trap quarries of Meriden, Conn., were also visited and extensive collections of the zeolites and other secondary minerals secured. The pegmatite localities of Collin's Hill in Portland; the workings of the old cobalt mine and the old lithia mine in Chatham, and a number of feldspar quarries in this region were visited and collections of the representative minerals secured. Much of the material collected as above has been carefully examined and descriptions will appear in forthcoming numbers of the Proceedings.

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Explorations for paleontological material were limited during 1919 to two short field trips by Dr. R. S. Bassler, Curator of Paleontology, who continued the work of former years in securing certain large showy specimens of fossils and rocks required for the exhibition series. Dr. Bassler spent a portion of June in southeastern Indiana, first proceeding to the locality where at the end of the field season of 1918 he had cached for safe keeping, because of inability to secure help in getting them to a freight station, several large exhibition slabs crowded with brachiopod shells. These slabs were

FIG. 18.—Fossiliferous strata of the Richmond formation in southeastern Indiana. The slab indicated is now on exhibition at the National Museum. Photograph by Bassler.

found undisturbed, but transportation conditions proved equally bad as in the summer before and it became necessary to employ the primitive method shown in figure 17. By the use of burlap covering and an abundant supply of weeds for padding, each slab was finally slid along the rails for a considerable distance to the nearest station.

The same area in Indiana, namely, the vicinity of Weisburg where the early Silurian rocks are well exposed, was then explored for further desirable exhibition specimens. Water worn slabs crowded with animal and seaweed remains are abundant in all the creeks of

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this richly fossiliferous region, but large rock specimens with their surfaces unweathered are comparatively rare. Fortunately for the present purposes, heavy freshets in the spring of 1919 had uncovered the richly fossiliferous layers along the creek shown in figure 18, and here several additional well-preserved exhibition slabs were secured and transported to the freight station by the rail route mentioned before. One of these specimens, a slab several feet in length and width, is worthy of special mention, as its surface is crowded with impressions of the branching fossil seaweed *Buthotrephis,* and with excellent examples of the dumbbell seaweed *Arthraria.* The discovery of this specimen was most fortunate as a large slab containing an assemblage of these ancient plant remains has long been needed for the exhibition series of fossil plants.

In October, 1919, Dr. Bassler was detailed to proceed to Dayton, Ohio, in order to prepare for shipment to the Museum the largest entire American trilobite so far discovered. This unique specimen (fig. 19) was discovered in the Richmond formation in the excavations for the Huffman Conservancy Dam 6 miles east of Dayton, which forms a part of the greatest engineering project ever undertaken for controlling stream flow, with the exception of the Assouan Dam along the Nile. Following the destructive floods in the Miami valley in 1913, the Miami Conservancy District was organized to prevent a repetition of this disaster through the control of the Miami River and its tributaries by dams extending entirely across their valleys. This operation involving an expense of over fifteen million dollars has been under way for three years, and will require three years more for its completion. The view (fig. 20) showing the excavations in which the trilobite was found illustrates only the beginning of one of these dams. This particular dam when completed, will extend a distance of a mile entirely across the river valley. Normally the water will flow in its usual channel, but in flood times it will be retained and allowed to escape gradually.

The trilobite which was found lying on its back in a hard clay bed in the central part of the excavation was unearthed by the pick of a workman, who believed it to be a petrified turtle. Mr. Arthur E. Morgan, Chief Engineer of the Miami Conservancy District, recognized the true nature and scientific value of the so-called turtle and presented it to the Smithsonian Institution, where it now forms a most instructive and unique exhibit in the hall of invertebrate paleontology. The value of the specimen is further increased by the fact that it has become the type of the new species *Isotelus brachycephalus* described by Dr. August F. Foerste of Dayton, Ohio.

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During the summer of 1919, Mr. Frank Springer resumed his field researches upon the fossil echinoderms of the Ohio Valley, which had been interrupted by the war, with the special object of securing additional material from the remarkable crinoidal fauna of the Laurel formation of the Niagaran for use in his monograph on the Silurian crinoids. The principal work was done at St. Paul,

FIG. 19.—The type specimen of *Isotelus brachycephalus* Foerste, the largest known entire American trilobite. About ¼ natural size. Photograph by Bassler.

in Shelby County, Indiana, where Mr. Springer's assistant, Dr. Herrick E. Wilson, continued the systematic collecting and detailed study of the strata begun several years ago. Collecting in the beds at this locality is laborious and difficult, and specimens are not abundant, but they exhibit in some respects a strong parallelism with those of the Swedish and English Silurian, which renders

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their comparative study one of much interest. Important new material was obtained which is added to the collection of echinoderms deposited in the National Museum. Mr. Springer's monograph of the Crinoidea Flexibilia, now being published by the Smithsonian Institution, has been printed and only awaits binding to be ready for distribution. It will be in two quarto volumes, one of them containing 79 plates.

The Section of Vertebrate Paleontology has been unable to undertake any field explorations during the past year, and the time of the staff has been largely employed in preparing and mounting for exhibition material otherwise obtained.

FIG. 20.—View of small portion of Huffman Conservancy dam near Dayton, Ohio, showing excavation in which the largest trilobite was found. Photograph by courtesy of Arthur E. Morgan, chief engineer.

Through the acquisition from the veteran collector of fossils, Mr. Charles H. Sternberg, of an excellent skeleton of the large swimming lizard *Tylosaurus dyspelor* and a skull of the primitive horned dinosaur *Monoclonius,* an interesting addition to the exhibition collection was made. Figure 21 shows the *Tylosaurus* skeleton in process of being mounted for exhibition by Mr. N. H. Boss. It will form a panel, in half relief, and will occupy the wall space in the northeastern part of the main exhibition hall of fossil vertebrates. The diving pose given the skeleton was largely determined by the position of the articulated tail as found in the ground.

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Tylosaurus was a long, slender-bodied reptile some 25 feet in length, having the limbs modified into short swimming paddles, with a long, powerful, compressed tail. It was predatory in habits, living on fishes and probably also on the smaller individuals of its own kind. One of the unique features of the skeletal structure is the presence near the middle of the lower jaw of a joint which permits it to bow outward. This feature in connection with the loose articulation at the extremities allowed the jaws to expand and thus enabled the

FIG. 21.—The swimming reptile *Tylosaurus dyspelor* in process of preparation for exhibition. Photograph by Bassler.

animal to swallow large objects. In life the body was covered by small horny scales. A study of this specimen is being made by Mr. C. W. Gilmore, and the results of his investigations will be published in the Proceedings of the U. S. National Museum.

In figure 22 is shown another of the recently mounted skeletons—that of the large extinct Rhinoceros-like mammal from the Tertiary (Oligocene) deposits of western Nebraska, named by Osborn *Brontotherium hatcheri*. The bones of this skeleton were found em-

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bedded in a fine sandstone. An idea of the amount of painstaking work involved in the collection, preparation and mounting of such a large fossil skeleton may be gained by the fact that after the bones were collected and freed from the enclosing sandstone, 258 working days were spent in restoring the missing parts, posing the skeleton and making and fitting the supporting iron work.

The National Museum has now the distinction of having the largest existing collection of Titanothere remains. The specimens were

FIG. 22.—The Rhinoceros-like mammal *Brontotherium hatcheri* mounted in the laboratory of vertebrate paleontology. Photograph by Bassler.

brought together by the late J. B. Hatcher, working under the direction of Prof. O. C. Marsh, at that time United States Paleontologist, and it is peculiarly fitting that the only skeleton complete enough for mounting should pertain to the species named in his honor.

Among other important investigations in the mammalian division of the year is a study by Mr. Gidley of the Peccaries of the Cumberland Cave deposit. This includes the description of three new species, the redefinition of the Pleistocene species hitherto described,

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and the partial revision of the entire peccary family (Tayassuidae), the latter involving redefinitions of the two living genera of this group, and of the two suilline families Suidae and Tayassuidae. An important outcome of this preliminary investigation has been to emphasize the fact that the entire group, and especially the Pleistocene species of American suillines, is in need of thorough revision.

EXPEDITION TO SOUTH AMERICA IN THE INTERESTS OF THE ASTROPHYSICAL OBSERVATORY

Dr. and Mrs. C. G. Abbot sailed from New York on May 2, by way of the Panama Canal to Antofagasta, Chile. The expedition had three objects. First, to observe the total eclipse of the sun of May 29 at La Paz, Bolivia; second, to enable Dr. Abbot to confer with the officials of the Argentine Weather Bureau in relation to the use of the observations of the solar radiation for the purpose of forecasting weather conditions; third, in order that a visit might be paid at the observing station of the Smithsonian Institution at Calama, Chile, which is maintained by the Hodgkins Fund under the direction of Mr. A. F. Moore and assisted by Mr. L. H. Abbot.

Landing at Antofagasta, the journey was continued by the English railroad up into Bolivia over that desert which Darwin describes in his "Voyage of the Beagle." Although the travelers had visited the Sahara Desert in southern Algeria, and the deserts of the southwest of the United States, there was still reserved for them a stronger impression of a void wilderness in the Nitrate Desert of Chile. Neither bird, beast, insect nor crawling thing, nor any vegetation could be seen as far as the eye could reach.

Stopping a day at the observing station at Calama, in order to repack the apparatus required for the eclipse expedition, and joined by Mr. A. F. Moore, director of the observing station, they went on to La Paz. The plateau of Bolivia is eminently the country of mirage. The railroad appeared to rise out of a lake and to run into a lake at no distant point beyond, and all of the mountains appeared to be islands rising out of the lake. The desolation, while not equal to that of the Nitrate Desert of Chile, was yet very marked. Near La Paz the country becomes cultivated with fields of grain and vegetables, and villages of people are passed by on either side. The mountains take on a new grandeur, especially the great mountain Illimani, which rises to a height of 22,000 feet or more.

However one may have been impressed with the grandeur of the mountains, he is unprepared for the view of the great canyon in

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which La Paz lies. In most respects it is comparable with the Grand Canyon in Arizona, but with several added charms. First of all, on the farther side lies the great chain of the Andes, to which Illimani belongs, snow-covered although so far within the tropics, while on the nearer slope of the canyon all is green with vegetation, trickling

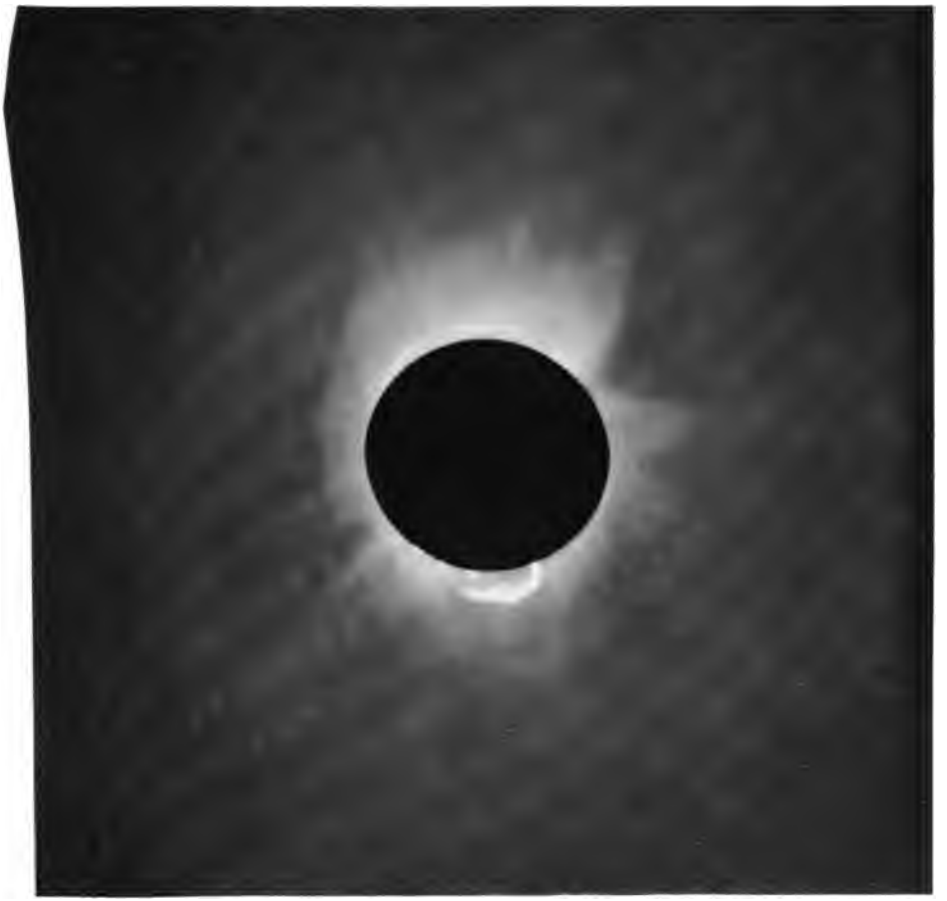

FIG. 23.—Total solar eclipse of May 29, 1919.

brooks running down, and the beautiful city lies upon its cluster of hills all surrounded by the colors and broken features which might result by combining the Grand Canyon of the Colorado with the Garden of the Gods near Colorado Springs.

By the kind assistance of the manager of the English railroad the eclipse station was located at El Alto, situated on the rim of the

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canyon at about 14,000 feet elevation. There the apparatus was set up, and on the day of the eclipse very satisfactory observations were made, both photographs of the phenomenon and measurements of the brightness of the sky and the nocturnal radiation. The accompanying photograph shows in but a feeble way how splendid was the eclipse phenomenon on this occasion. The corona extended at least two diameters of the sun in almost all directions, with a great profusion of fine streamers. Underneath the sun, that is to say towards the east, there hung a sickle-shaped solar prominence of hydrogen and calcium gases, extending fully 150,000 miles outwards from the sun and over 300,000 miles long, which cast its crimson glory over all. The background against which this splendid phenomenon was seen was a range of mountains, perhaps 50 miles distant, which raised their snow-covered heads fully 20,000 feet in altitude.

From La Paz, Messrs. Abbot and Moore proceeded at once to La Quiaca, Argentina, where they inspected the meteorological observatory and conferred with Messrs. Wiggin and Clayton, Chief and Chief Forecaster, respectively, of the Argentine Meteorological Service. Under Mr. Clayton's direction a system of forecasting by the aid of daily telegraphic reports of the intensity of the radiation of the sun as observed at Calama, Chile, has been worked out with encouraging success.

Both Mr. Wiggin and Mr. Clayton were firmly convinced of the great value of solar radiation observations for forecasting. Arrangements were tentatively entered into for the transfer of the Smithsonian observing station at Calama to the Argentine Government, to be located at La Quiaca thereafter. At the present time, however, these arrangements have not yet been completed by the higher officials of the Government of Argentina.

From La Quiaca the travelers returned to the observing station at Calama, Chile, where Dr. and Mrs. Abbot remained about a month before returning to the United States, during which time Dr. Abbot worked over the results obtained with a view to discovering some means of measuring the intensity of the solar radiation without the long and tedious process of observing and computing which has hitherto been necessary. In this he was so fortunate as to discover, with the aid of Mr. Moore, a method by means of which suitable observations taken within a period of 10 minutes may be reduced within a period of 2 or 3 hours. Thus the intensity of the solar radiation outside the atmosphere may be determined with greater accuracy than by the former method which required about 3 hours of observing and about 15 hours of computing.

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FIG. 25.—Mine Storehouse Near Calama.

FIG. 27.—Chilean Family at Calama.

FIG. 24.—Disembarking at a Chilean Port.

FIG. 26.—Lock at the Panama Canal.

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Mt. Wilson observations.—As usual, the station at Mt. Wilson was occupied from May until October by Mr. L. B. Aldrich, who carried on there the usual measurements of the " solar constant of radiation," and some others intended to determine the intensity of the nocturnal radiation and the intensity of skylight.

AUSTRALIAN EXPEDITION

The zoological work by Mr. H. C. Raven in Borneo and Celebes, which has been made possible through the generosity of Dr. William L. Abbott, came to an end in 1918, as explained in the last Explora-

FIG. 28.—A pair of adult duck-bills, the male (at left) showing the spurs on hind feet.

tion Report (p. 35). At the close of the war Mr. Raven did not wish to return immediately to the field. Doctor Abbott therefore arranged to send Mr. Charles M. Hoy to Australia for the purpose of collecting vertebrates, especially those which are in danger of extermination. From the point of view of the national collection of mammals there is probably no field-work of similar scope that could approach this in importance. The fact has long been recognized, but the means for putting such a project into execution have hitherto been

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lacking. The remarkable Australian mammal fauna is now represented in the museum by only about 200 specimens. Very few of these have been collected in accordance with present-day methods, and no species is represented by adequate series of adults and young, of skeletons and material in alcohol. Not only is this true of our collection, but it is equally true as regards other museums in America. So many of the Australian mammals are now rapidly approaching extermination that in future there will be few opportunities for securing the material needed for a proper representation of the fauna.

Mr. Hoy spent about two months in Washington assembling his outfit and preparing for his trip. He left for San Francisco early in

FIG. 29.—Two young duck-bills in their nest.

May and arrived in Sydney about the end of the month. The period from June to November has been passed at various localities in New South Wales. While no specimens have yet been received (December 31, 1919), it is evident that the work has been very successful. The following passages from Mr. Hoy's letters and reports will give an idea of the conditions under which it has been carried on:

"Travel is rather difficult just now. Each state has its own quarantine restrictions, on account of the 'flu' and it is quite difficult to get from one to the other. Then too a seaman's strike is on, making travel by boat very uncertain. The railroads are run by the state governments and each state has a different gauge road and different rates.

"I have a great chance to get Platypus (duck-bill). A Mr. Burrell, whose hobby is Platypus is going after them on the first of October. As he has

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kindly offered to take me with him and is only interested in the natural history, it will be a great chance for me to get not only the adults but also the young and possibly an egg. Mr. Burrell is after their nesting habits and is taking men along to dig out the burrows. It is safe to say that there is not another man who knows as much as he about the duck-bill.

"Nine weeks were spent in the Wandandian region (19 miles S. W. of Norwra, N. S. W.) with the result of but one hundred and thirty one (131) mammals, and one hundred and twenty-four (124) birds collected. Among the mammals ten genera and twelve species are represented in my collection.

"The greatest agent working toward the extermination of the native animals is the fox, next comes the cattle and sheep men who distribute poison by the

FIG. 30.—An Australian marsupial with parachute membrane like that of the flying squirrel.

cartload in the effort to reduce the rabbits. This has also caused or helped to cause the extermination of some of the ground inhabiting birds. Another great agent is the bush fires which sweep over the country. These are often lit intentionally in order to clear out the undergrowth and thus increase the grass.

"Owing to the great increase in the price of rabbit skins and the consequent increase in trappers the rabbits are fast ceasing to be a pest, and in some sections have become quite scarce. The foxes, which are everywhere numerous, after killing off the native mammals are now turning to the rabbits, which also helps in their reduction. The extermination of the native mammals has apparently gone much farther than is generally thought. Many species that were plentiful only a few years ago are now almost, if not alto-

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gether, extinct. Diseases have also played a great part in the extermination. The native bear died in thousands from a disease which produced a great bony growth on their heads. A mysterious disease also spread through the ranks of the native cat, *Dasyurus viverrinus;* the domestic cat also played a great part in their extermination. Even adult specimens of *Dasyurus* were often dragged in by the family cat.

"The only mammals caught in traps were *Mus assimilis* and *Phascologale flavipes.* The others were all shot or snared. As the majority of the mammals taken were nocturnal and arboreal, the headlight proved to be a valuable

FIG. 31.—An Australian marsupial resembling a very large flying squirrel.

and indispensable part of my outfit. The hunting of kangaroos and wallabies was greatly handicapped through the lack of a rifle.

"*Perameles nasuta* has been practically exterminated throughout N. S. W., but they are still to be found in Mosman, one of Sydney's suburbs, so I made a trip out there and was able to get a fine female with two young in her pouch. This was trapped inside the Taronga Park Zoo grounds with the kind permission of Mr. A. S. Le Souëf.

"The fact of *Perameles nasuta* being found at Mosman is probably due to the isolation of that district from the rest of N. S. W. by the city of Sydney, thus keeping out the introduced foxes.

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"The country at Bulliac is a good example of what the cattle men will do in a few years time in killing off and burning the timber and the consequent destruction of animal life. Five years ago Bulliac was a virgin forest but then the railroad was built and now it is devoid of living trees for miles on each side of the track except for small and scattered patches in the more inaccessible gullies which form the last resort of the fast disappearing mammals. There are very few game laws in Australia and no one gives any attention to the ones that are in order. The Bulliac trip has clearly shown that the edge of the settlements, and even a short way into the wilds, is no better than the older settled parts and in order to get results one must go into the wilds. It is the killing and burning of the brush, by the cattle men, that does the most to kill off the animals, and they are yearly reaching farther and farther away from the railroads. One thing that was very noticeable was the great abundance of the introduced rats. They seem to have driven out or killed off practically all the native rats and I found them everywhere.

FIG. 32.—Skinning a kangaroo.

"A trip was made primarily for the eggs and young of the Platypus. Fifty miles of bank was searched and approximately one hundred burrows were dug out only six of which contained young. These six burrows furnished eleven young of which Mr. Harry Burrell, of Sydney, with whom the trip was made, secured 7 while I secured 4. The intense drought which has scarcely been broken for over twelve months (it is the worst since 1862) has advanced the breeding of the animals somewhat so we were too late for eggs. The Platypus although scarce is not by any means nearing extinction and if they continue to be protected there is every hope that they will never become extinct. Young *Hydromys* were also looked for but the drought seems to have interfered with their breeding and but two embryos were obtained. The adults themselves were very scarce and but six specimens were obtained.

The accompanying photographs show some of the characteristic Australian mammals obtained by Mr. Hoy.

G. S. MILLER, JR.

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THE COLLINS-GARNER CONGO EXPEDITION

The Collins-Garner Congo Expedition returned to this country in May, after having spent more than two years in the collecting of natural history material in French Congo. Mr. C. R. Aschemeier,

FIG. 33.

FIG. 34.

FIGS. 33, 34.—Skulls of gorillas collected by Aschemeier in French Congo. Young adult male at left; adult female at right.

who represented the Smithsonian Institution, brought back with him the bulk of material collected. Among other things Mr. Aschemeier collected about 2500 birds and mammals, which added invaluable material to the museum collection.

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EXPLORATIONS IN SANTO DOMINGO

Dr. W. L. Abbott continued his investigations at the eastern end of the Island of Haiti, making two visits during the year 1919. His first visit was to the Samaná Bay region and to the mountains in the vicinity of Sanchez and Constanza, and covered the interval from February to June. On his second trip (July to October) he stopped at Sosua, on the north side of the island, where he made a search for certain birds needed to fill gaps in the material already collected; thence to the Samaná Peninsula, after which he went to the islets Saona and Catalina, off the southeastern corner of Santo Domingo. Before returning to Philadelphia, he spent a few days at Lake Enriquillo, where he secured a few water birds of interest.

The material gathered on these two trips was varied in character, embracing the several groups of vertebrates, as well as mollusks, insects, and plants, with a plentiful series of archeological objects from caves in the Samaná district. Of birds alone, he obtained 278 study skins, 87 alcoholics and skeletons, and 56 eggs. Four species of birds in this collection represented forms not hitherto possessed by the Museum, and three or four other species were not previously known to occur on the island. Probably the most noteworthy objects in the bird collection were four eggs of the *Dulus dominicus*, known variously as the Sigura, Palm Slave, or Palm Chat, a bird somewhat larger than an English Sparrow, of sombre colors, but structurally different enough from other birds to occupy a family by itself. It is common and noisy, and lives in colonies, and its enormous "apartment house" nests are sufficiently noticeable to attract the attention of the most casual person. The discovery of the Palm Chat was almost coincident with that of America, for Columbus and his men must have seen these birds and their nests when a landing was made on this island at the end of 1492. Oviedo, the official historian of the Indes, early made its acquaintance, and devoted a chapter to it in his "Hystoria natural y general de las Indias yslas," published in 1535. The Sigura was thus one of the earliest, and at that time one of the best-known birds of the new continent. Various authors of later date have described the bird, its habits and nests, but thus far, apparently no correct description of the eggs has been given, although a French writer, in 1851, reported them to be white and unmarked.

The eggs sent by Dr. Abbott are authentic, and will be described in detail elsewhere, but the illustration here given (fig. 35) will convey a general idea of their appearance, and it may be remarked

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that the eggs are rather large for the size of the bird, measuring, roughly, about one inch by three-quarters of an inch in diameter. The description of the nest, as furnished to Dr. Abbott by the man who made the actual examination, indicates a radical departure from other known types of birds' nests, but a careful study of the interior of the mass by a competent observer will be required before the strange arrangement of the individual nests can be considered as accurately known. Dr. Abbott writes: "The communal nest was

FIG. 35.—Eggs of the Palm Chat (*Dulus dominicus*).

built in a small royal palm, about 25 feet from the ground. The nest was about 4½ feet in diameter, and about the same in height. Built of a loose mass of sticks from 1 to 2 feet long, about the thickness of bone knitting needles. There appeared to be but one entrance, from above. A local man (John King) climbed the tree and gave me the description of the *internal* construction of the nest. The entrance passage was narrow and crooked and led into a large central chamber about the size of a small bucket. The nests were placed around this on shelves of softer materials (fine bark, etc.). All four eggs were in one nest. The other five nests were still empty.

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"It is difficult to get into these nests, the huge smooth palm trunk (2 feet in diameter) must be climbed, and then it is difficult to crawl over the huge mass of sticks which lie interlaced amongst the crown of leaf stalks.

"Most of the nests are in far larger palms than this one, and the nests are frequently much larger in size, and probably contain much larger colonies."

FIG. 36.—Dense forest of giant cedar (*Thuya plicata*) near Lake McDonald, Glacier National Park.

BOTANICAL EXPLORATION IN GLACIER NATIONAL PARK, MONTANA

Mr. Paul C. Standley, assistant curator in the division of plants, spent the summer of 1919 in Glacier National Park, Montana, under the authority of the National Park Service, for the purpose of study-

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ing the vegetation of the region. The information thus obtained is to serve as the basis of a popular account of the plants to be published by the National Park Service, and it is expected that a complete and more technical account of the flora will be published by the National Museum. All the portions of the Park usually seen by tourists were explored, and 4,000 specimens of flowering plants and ferns were obtained, representing over 900 species.

Aside from the scenic features of Glacier Park, one of its chief attractions is found in the plant life. Especially striking is the display of flowers above or near timber line, where the meadows are solid masses of brilliant color, formed by Indian paint-brushes,

FIG. 37.—Beargrass, Glacier National Park.

monkey-flowers, fleabane, asters, harebells, heather, larkspur, gentians, fireweed, columbine, and a host of other plants. The most characteristic plant, perhaps, is the beargrass (*Xerophyllum tenax*, fig. 37), which occurs abundantly at middle altitudes and in alpine meadows. It is usually about 3 feet high and bears enormous plume-like racemes of creamy-white flowers. The narrow, tough leaves were used by the northwestern Indians in making baskets, hence the name of Indian basket-grass which is sometimes applied to the plant.

The Continental Divide, which traverses the Park, has a marked influence upon plant distribution. On the east slope, whose drainage is partly into the Missouri River and partly into Hudson Bay, the flora is of the Rocky Mountain type, like that of Wyoming and Colo-

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FIG. 38.—Sperry Glacier, Glacier National Park. There are over 60 glaciers in the Park. Photograph by R. E. Marble.

FIG. 39.—St. Mary Lake, Glacier National Park. Photograph by Fred H. Kiser.

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rado; while on the west slope, whose streams drain into the Columbia River, the flora is more obviously related to that of the Pacific Coast. The forests about Lake McDonald are very dense and are

FIG. 40.—Gunsight Lake from Gunsight Pass, Glacier National Park. Photograph by R. E. Marble.

composed of unusually large trees. Although not nearly so extensive, they are much like those of the humid regions of Oregon and Washington.

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FIG. 41.—Trail to Swiftcurrent Pass, Glacier National Park; Swiftcurrent Glacier in the distance. Photograph by Scenic America Company, Portland, Oregon.

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In the vegetation there are represented four of the life zones recognized by biologists. The Transition Zone is indicated on the west slope by small areas of yellow pine timber, and east of the Park are the prairies of the Blackfoot Indian Reservation, which extend also within the Park boundaries along the stream valleys. The plants here are chiefly herbs, with a few shrubs, and they belong mostly to species which have a wide distribution over the Great Plains. By far the largest portion of the Park is covered with the characteristic vegetation of the Canadian Zone, which is the heavily forested area. Above the Canadian Zone, around timber line (6,000 to 7,500 feet), lies a narrow belt belonging to the Hudsonian Zone. The trees here are mostly low and stunted, and their branches frequently lie prostrate upon the ground. Above this belt, and occupying the highest, exposed slopes, lies the Arctic-Alpine Zone, whose vegetation is composed chiefly of small herbaceous plants, with a few dwarfed shrubs, mostly willows. Many of the species of this zone are widely distributed in alpine or arctic regions of North America, and some of them occur also in similar situations in Europe and Asia.

EXPLORATIONS AND CERION STUDIES ON THE FLORIDA KEYS

Dr. Paul Bartsch, curator of marine invertebrates, U. S. National Museum, joined Dr. Alfred G. Mayer, the Director of the Tortugas Marine Biological Laboratory, of the Carnegie Institution, in New York on December 28, when they sailed south for Key West to make an examination of the Cerion colonies discussed in previous Smithsonian exploration pamphlets. The breeding experiments presented an entirely new phase, in the crossing, on one of the keys, of the native species, *Cerion incanum* (Binney) with one of the introduced Bahama species, *Cerion viaregis* Bartsch. It was this discovery that made it desirable to start an entirely new set of experiments. Furthermore, the anatomical differences discovered in the dissections of Cerions also made it desirable to gain material from all the colonies now existing on the Florida Keys, in order that these might be subjected to anatomization, to determine if *Cerion incanum* is really one species, or a complex, shell characters alone being insufficient to determine this point. It was for this double reason that a return was made to Florida on May 2, and an exploration of the keys adjacent to Miami at once undertaken.

On the 3d Capt. Tracy and Dr. Bartsch started in the "Darwin," a shallow draught launch of the Carnegie Institution, for an exploration of the shores of the mainland of the lower peninsula and the

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outside keys. This was rendered comparatively easy, since they were fortunate enough to find the mosquito pests practically absent. Between May 3 and 6 they examined every sandspit on the mainland along Key Biscayne Bay, Card Sound, Little Card Sound and Barnes Sound. They then turned the southern portion of Barnes Sound and came up along the outer keys, examining them in turn. They crossed Key Largo at several places and walked long stretches in its interior.

No Cerions were found on the mainland between Miami and the point where the railroad enters the keys, but two colonies were dis-

FIG. 42.—Nest of swallow-tailed kite (*Elanoides forficatus forficatus*) between Flamingo and Coot Bay, Cape Sable, Florida.

covered on keys a very short distance from the mainland in Barnes Sound. One of these is situated on a sandspit covered with grass and shrubbery on Middle Key, while the other one was found in a clearing on the southeastern point of Main Key. No Cerion colonies were discovered on the keys forming the eastern perimeter of Barnes Sound, Little Card Sound, Card Sound and Key Biscayne Sound, excepting Porgee Key, where a goodly quantity were obtained, some of which have been dissected and published upon in the bulletin on "Experiments in the Breeding of Cerions" recently issued by the Carnegie Institution. In addition to Cerions, collections of all the other species of land mollusks available were made wherever found at

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all the places visited, especial stress being laid upon the securing of series of the most beautiful of our American landshells, the tree snail Liguus, anatomical material of all of which was preserved in order that this group may also be subjected to a close scrutiny in an anatomical way. What is said for Liguus also applies to the equally large, though less brilliantly colored Oxystyla.

On the 7th the " Anton Dohrn " left Miami for Indian Key, spending the night off Rodriguez Key, and reaching Indian Key early on the following day. By 10 o'clock Capt. Tracy, McIvar, the Assistant Engineer, and Dr. Bartsch were off in the " Darwin " with the skiff

FIG. 43.—Characteristic vegetation where the prairie and hammock meet, Coot Bay region, Cape Sable, Florida.

in tow for the Cape Sable region. They skirted the outside of the Lower Matecumbe Key, passed through the viaduct and then headed across the extensive flats of Florida Bay. The first stop was made on Sands Key, where a burned out colony of Cerions and a well flourishing colony of Oxystyla and Liguus were found.

The expedition next headed for Flamingo City, which was reached at sundown. On May 9 they explored the region about Flamingo City and the coast for several miles to the east, for Cerions, and other mollusks. Cerions were not found, but large numbers of beautiful Liguus and Oxystylas were noted everywhere. A trip was then made by wagon to Coot Bay.

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Coot Bay is a fine sheet of water fringed by tall mangroves, showing even at this season a sprinkling of water fowl. The evaporation from the lake at night undoubtedly keeps the adjacent region supplied with moisture, and is responsible for the large number of epiphytic plants which render the region a veritable hanging garden. Orchids and tilandsias fairly draped and seemed to almost smother the trees and shrubs. Here we saw quite a number of rare birds, and among them the swallow-tailed kite, of which no less than six specimens were observed in the air at one time.

On the 10th an exploration was made of the region between Flamingo and the middle of the bight between Middle Cape and

FIG. 44.—Young great white heron (*Ardea occidentalis*) on the lookout for his parents.

West Cape, but the search was rewarded with only a couple of dead specimens occupied by hermit crabs which probably had been drifted in here by the winds from the Sands Key colony. Liguus were found in many places, and so were Oxystyla and other species.

On the evening of the 10th the party headed for Indian Key, stopping again at Sands Key, where they found a most remarkable flight of Florida yellow throats. Every tree and every shrub seemed to have on every branch one or more of these little fellows. On the morning of the 11th sail was set from Indian Key for the Newfound Harbor group, where the next two days were spent in examining the chain of keys that extends southwest from Big Pine Key, for Cerions

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and other mollusks. A very flourishing colony was found on the northeast point of the first key southwest of Big Pine Key, where were gathered no less than 75 specimens in a square foot of beach, covered by grass. Another colony was found on the second key

FIG. 45.—A nest of Ward's heron (*Ardea herodias wardi*) in gumbo limbo tree.

southwest of Big Pine Key. A colony was discovered likewise on the third key southwest of Big Pine Key. The fourth key is a mere clump of mangroves and did not contain Cerions. On the fifth key southwest of Big Pine Key a colony had been planted in 1912, and it is here that the crossing between the native and Bahama species has

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taken place. On the sixth key no Cerions were found, but there was secured the new clapper rail which has since been described as *Rallus longirostris helius,* by Dr. Oberholser. Here, also, the pictures of the Ward's heron (*Ardea herodias wardi*) nest and young were taken. This key might really be called Rail Key. In the seventh no Cerions were found, but the great white heron (*Ardea occidentalis*) was found breeding, and it was here that we secured our photographs of this bird and the specimen, which was shipped to the Zoological Park at Washington by parcel post from Key West. It is believed that this is the first time this species

FIG. 46.—Young great white heron (*Ardea occidentalis*) in the nest in a mangrove thicket.

has been shown in any zoological garden. The eighth and last key is a mere clump of mangroves without Cerion possibilities.

On the evening of the 12th the expedition headed for Key West. A large collection of Cerions was made near the Bureau of Fisheries station, to be used for breeding purposes at the Tortugas.

A new set of experiments was started on Loggerhead Key, Tortugas. Ninety cages of bronze wire, 2′ x 3′ x 3′ high, were constructed in which were placed one specimen each of two species. In addition to this nine cages 6′ x 8′ x 3′ high were built, in which 50 each of the two species were placed.

On the 19th opportunity presented itself to return to Key West on a submarine chaser.

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A summary of the results so far obtained from the breeding experiments has recently been published as a bulletin by the Carnegie Institution. The results are rather startling, and incline one, contrary to the views previously held by most people, to the belief that Cerions are not easily influenced, if at all, by environmental factors. The cross obtained in the Newfound Harbor colony opens up an entirely new vista in the problem of speciation, and it was this which was responsible for the starting of the new set of breeding experiments.

Incidental to these investigations, which have been conducted since 1912, a list of the birds observed on the various keys has been kept and published annually in the Year Book of the Carnegie Institution.

FIELD WORK ON THE MESA VERDE NATIONAL PARK, COLORADO

The field-work of Dr. J. Walter Fewkes, Chief of the Bureau of American Ethnology, at the Mesa Verde National Park, in the summer of 1919, was devoted to the excavation and repair of the picturesque cliff dwelling, Square Tower House, known for many years as Peabody House, and two low prehistoric mounds situated among the cedars on top of the plateau. This work was a continuation of that of previous years and was carried on in cooperation with the National Park Service of the Department of the Interior. As Square Tower House has several unique structural features, the summer's work has added to the educational attractions of the Park. At least two new types of hitherto unknown small-house ruins were discovered, and it is believed that a new page has been added to the history of the Mesa Verde cliff people. Dr. Fewkes was assisted in his field-work by Mr. Ralph Linton, a temporary assistant, who contributed much to the success of the work.

The main object was to gather data that may aid one to better comprehend the Indian civilization that arose, flourished on the Mesa Verde, and disappeared from the plateau over four centuries ago.

Square Tower House is situated in a shallow cave at the head of a spur of Navaho Canyon opposite Echo Cliff, about 2 miles south of Spruce Tree Camp. It has long been considered by tourists one of the most attractive cliff dwellings of the park, but its inaccessibility has deterred all but the most venturesome from descending to it from the rim of the canyon. Part of the old Indian trail (fig. 47) was indicated by shallow foot holes cut in the almost perpendicular cliffs, and previous to the past summer this was the only means of access.

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Without mutilating the vestiges of this primitive trail another was made in the cliff near it, around which was constructed a balustrade (fig. 48), with ladders conveniently set to aid those who wish to visit the ruin.

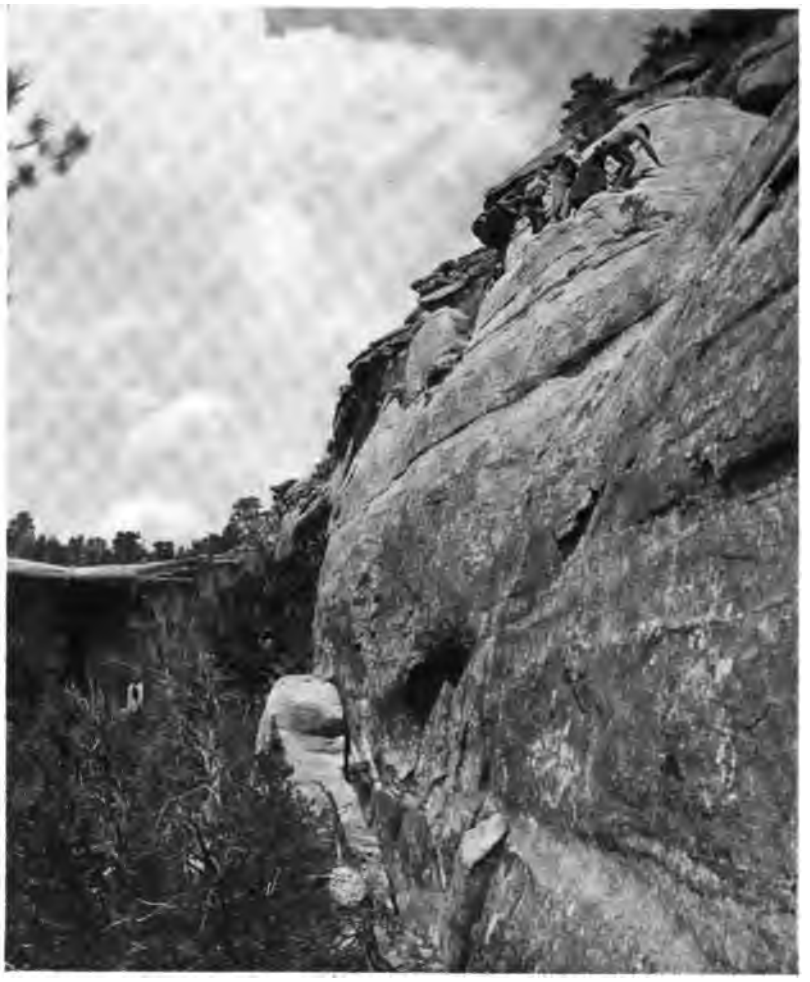

FIG. 47.—The Indian trail from the canyon rim to Square Tower House. The cliff below is almost perpendicular for over a hundred feet. A party of vistors aided by a rope is shown climbing along the trail. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande R. R.

Square Tower House (fig. 49) measures 140 feet in length and averages three stories high, with seven circular subterranean sanctuaries or kivas. The floor of the eastern end of the cave is composed

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of large boulders fallen from the roof; that of the western end is lower and comparatively level. The original entrance to the building, like that of the Cliff Palace, Far View House, and Sun Temple,

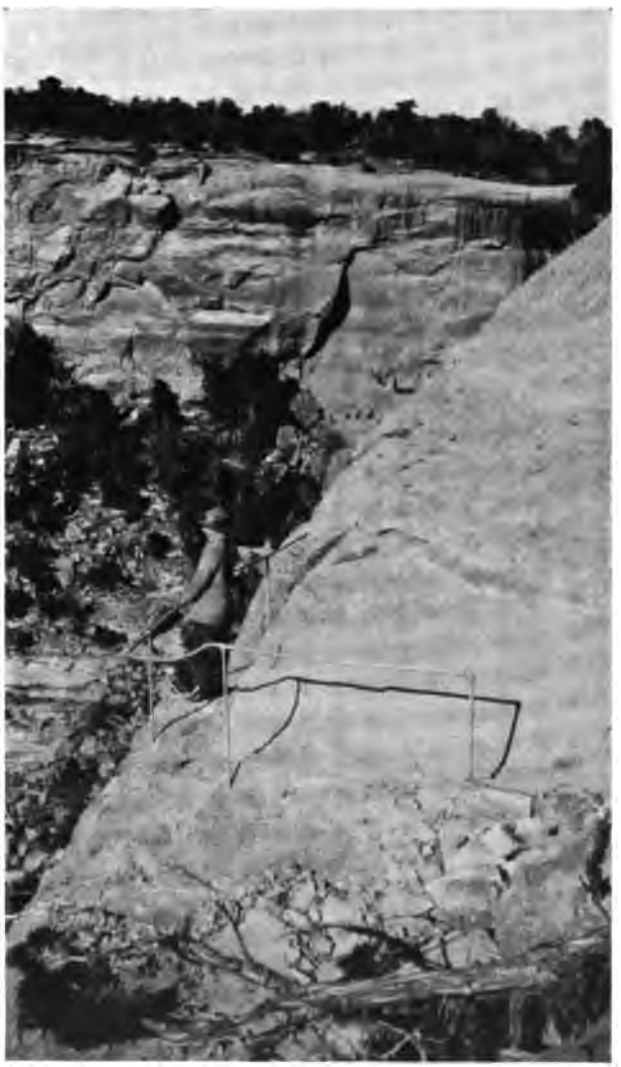

FIG. 48.—The footpath blasted in the cliff at the most difficult part of the ancient trail where the tourists are represented in figure 47. Photograph by Fred Jeep.

is a recess in the front wall. On the western end of the ruin there protrude radiating walls of basal rooms, one story high, suggesting

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a terrace. The rear wall of the cliff rises almost perpendicularly from the floor with no recess back of the buildings. The destructive effects of water dripping from the canyon rim are most marked midway in the length of the building where the walls (fig. 50), now reduced to their foundations, were formerly at least two stories high.

The walls of the ruin were in bad condition when the work began:

FIG. 49.—Square Tower House before excavation and repair, from Canyon rim.

great gaps in the masonry of the tower having rendered it in danger of falling. The interiors of the rooms were choked with fallen stones and the dust of ages. Two months given to excavation and repair have put the ruin in fine condition, exhibiting a good example of the best type of Pueblo architecture (figs. 51 and 52). The special attractions of Square Tower House are the remains of the roofs of two kivas and the high tower rising midway in its length.

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The original roof beams (fig. 53) of these two kivas are almost wholly intact. Considering how few kiva roofs on the mesa have survived destruction in the lapse of time, especial care was exercised

FIG. 50.—View of Square Tower House from the west, before excavation and repair. Photograph by Fred Jeep.

to preserve these and to indicate their mode of construction, and a model (fig. 54) has been made, photographs of which, in successive stages of construction, are given (figs. 54, 55). A good understand-

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ing of the construction of a typical kiva is especially important, as it distinguishes cliff houses of the Mesa Verde from those found elsewhere in the Southwest as well as in foreign lands.

FIG. 51.—Square Tower House excavated and repaired as seen from the southwest. Photograph by Fred Jeep.

FIG. 52.—View of the Tower completely repaired. Photograph by Fred Jeep.

The kivas of Square Tower House are circular, subterranean in position, and entered by a hatchway. Each kiva has a fire hole *F*, and near it an opening in the floor called the sipapu, *L*, which is very

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sacred because it symbolizes the entrance to the underworld. Over it in Hopi ceremonies is erected the altar, and through it the priests call to their kin in the underworld. A most instructive feature in the structure of the kiva is the means of ventilation. Between the fire hole and the wall there is an upright slab of stone, *H*, a wall of masonry, or simply upright sticks covered with clay. The function of this object is to deflect pure air which enters the room from a shaft opening outside, *G;* the ventilator is morphologically the survival of the doorway of the earth lodge or prototype of the kiva.

FIG. 53.—View from below of one sector of original roof logs of kiva A. Photograph by Gordon Parker.

A characteristic feature of the kiva is the roof, which rests on six mural pilasters, *C;* the intervals between which are called banquettes, *B*, that (*A*) over the ventilator being wider and broader than the others. The pilasters support logs, *D*, D^1, D^2, laid one above another in the form of cribbing. Short sticks, D^2, are placed at right angles to the cribbing to prevent sagging. Upon this cribbing are laid logs over which is spread cedar bark to support the clay covering the roof. The hatchway, which also served for the passage of smoke, is situated in the roof above the fire hole. In the construction of this roof, men of the Stone Age in America were not far from the discovery of the principle of the dome.

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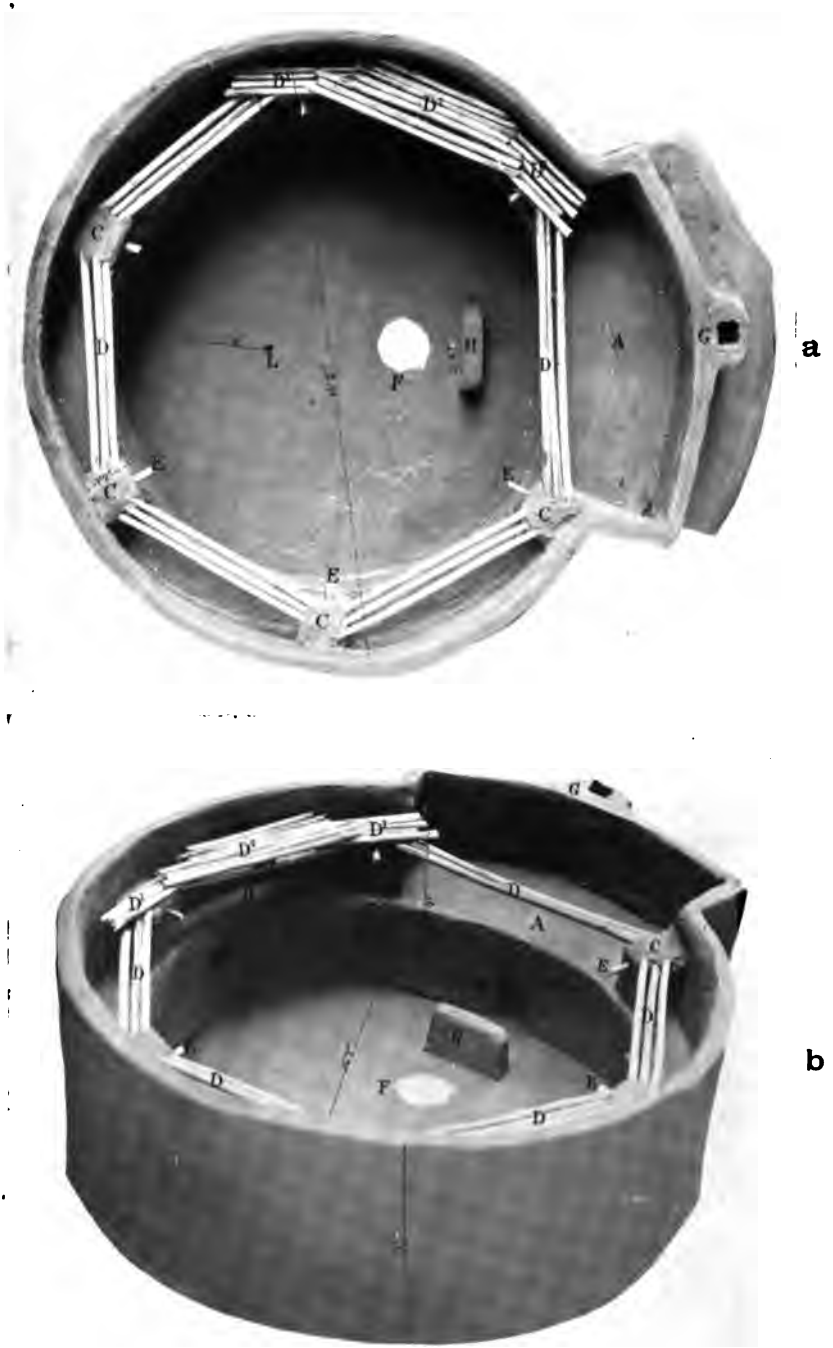

FIG. 54.—Model of a typical prehistoric kiva of the pure pueblo type. The photograph shows the model from above (*a*) and from the side (*b*), with first roof beams in place. Photographs by De Lancey Gill.

A, large banquette.
B, small banquettes.
C, pilasters to support roof cribbing.
D, beams of lower level of roof.
D^1, beams of second level of roof.
D^2, beams of third level of roof.
D^3, logs to prevent sagging of roof.
E, pegs for ceremonial paraphernalia.
F, fire hole.
G, external opening of ventilator.
H, fire screen, or pure air deflector.
I, niches for sacred meal.
K, floor entrance to ventilator.
L, ceremonial floor opening or *sipapu*.

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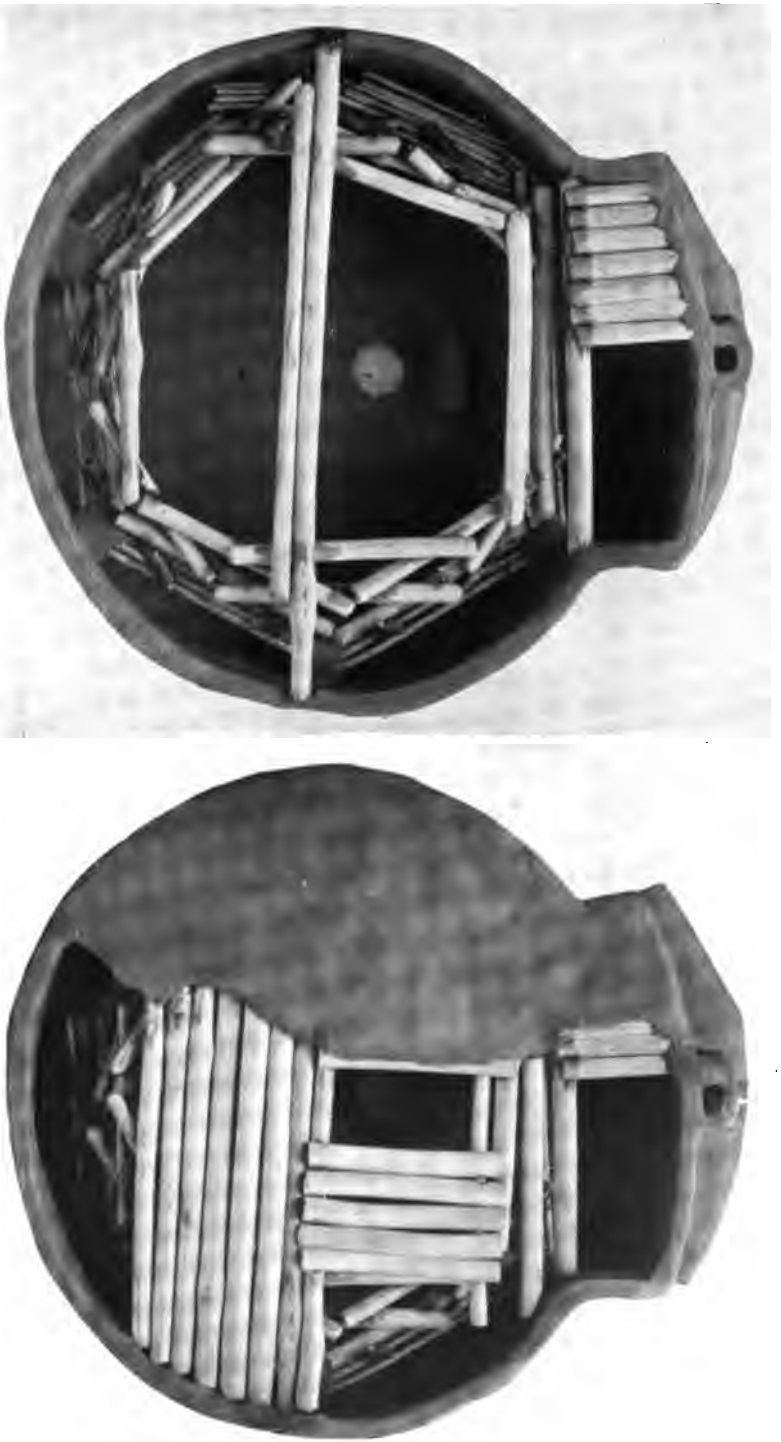

FIG. 55.—Model of typical kiva of the pure pueblo type; *a* shows construction of roof beams; *b*, half-covered roof and hatchway. Photographs by De Lancey Gill.

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The most striking feature of Square Tower House is the tower from which it takes its name. The cave in which it is situated having no recess at its back, there is consequently no refuse heap in the

FIG. 56.—Middle section of Square Tower House from the Crow's Nest. Photograph by Fred Jeep.

rear, such as was utilized at Spruce Tree House for mortuary purposes. The rear wall of the tower is formed by the perpendicular cliff (fig. 56). As shown by windows, doorways, and remnants of

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flooring, this tower is four stories high. The inner plastering of the lowest story is painted white with a dado colored red; its roof is likewise well preserved.

A room near the western end, (fig. 57) of the ruin has doors and windows closed with secondary masonry, and in the rubbish, half filling the neighboring kivas, human bones were found, indicating

FIG. 57.—Western end of Square Tower House, excavated and repaired. Photograph by Fewkes.

that the western end of the ruin was deserted and used for mortuary purposes before the remainder of the ruin was abandoned.

There is no archeological evidence that the tribes to the east, north, and west of the cliff dwellers and stone house builders of the Pueblo area were stone masons. On the south of the area, in the valley of the Gila, Santa Cruz, and San Pedro, looking toward Mexico, the ancients built their houses of earth and logs, and while the prehistoric buildings on the southern tributaries of the San Juan resemble those

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on the Mesa Verde they are quite different from the pueblos now inhabited. A logical interpretation of the geographical distribution of ruins with kivas like those of Square Tower House would not be that the knowledge of stone masonry was introduced from Mexico, but that the craft was acquired after the original inhabitants entered the country, and that the pure pueblo type, or that with kivas like those of Square Tower House, was born, cradled, and reached its highest development in the area where it was found. But we may

FIG. 58.—Wall of Earth Lodge A, showing adobe plastering on earth; the horizontal log is a roof beam. Photograph by T. G. Lemmon.

take another step, and point out that the prototype of these prehistoric kivas has a morphological likeness to "earth lodges."

The discovery of Earth Lodge A in this area by my assistant, Mr. Ralph Linton, was important, considering the light it may throw on the genesis of cliff dwellings. This ancient prototype (fig. 58) of a kiva is a semicircular isolated room with a slightly depressed floor in which is a centrally placed firepit, the surrounding walls being either adobe plastered on the earth or molded into clumps shaped like rolls. In this rude sunken wall were set at an angle posts, now charred at the free ends, all that remains of the supports of roof and sides.

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Earth Lodge A was not only excavated but a shed (fig. 59) was built over it for permanent preservation. While it is interpreted as the prototype of a kiva, it was formerly the dwelling of a family or other social unit dating to an epoch much older than that of the cliff dwellers. On opposite sides of the fire hole at the periphery of the floor, but within the outer walls, are small square or rectangular cists made of stone slabs set on edge. The indications are that these were covered with sticks and clay, suggesting the so-called slab houses. The pottery found in these cists is very crude, undecorated, and not of the cliff house type.

FIG. 59.—Shed built over Earth Lodge A to protect it from the elements, north end, entrance opposite. Photograph by Fred Jeep.

There are many sites resembling that of Earth Lodge A before excavation awaiting investigation on the top of Mesa Verde. Near it was a mound which when opened proved to be a unit-type house. The crude masonry and rough pottery found in it indicate an advance on the walls of an earth lodge, but the former is inferior to that of a kiva of the highest development, suggesting that it is an intermediate form between Earth Lodge A and Square Tower House. The spade revealed that after this room was first deserted débris had filled the depression a few feet deep on which a new fire hole and a grinding bin had been made of stone slabs on edge in the middle of the depression. Later on it was again abandoned and human bones had been thrown on the débris that formed over the grinding bin,

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indicating that the depression had become a dump place. Last of all, these were also covered by accumulated sand and soil, leaving only the top stones of a pilaster projecting above the surface.

FIG. 60.—Idol of the germ-god set by author in cement at head of the stairway, near kiva B. Photograph by Fred Jeep.

The pottery found in this crudely constructed kiva is more varied, but still an advance on that excavated in Earth Lodge A. It may be classified as black and white, and corrugated, but so inferior to that typical of cliff houses that it can be readily distinguished. From this

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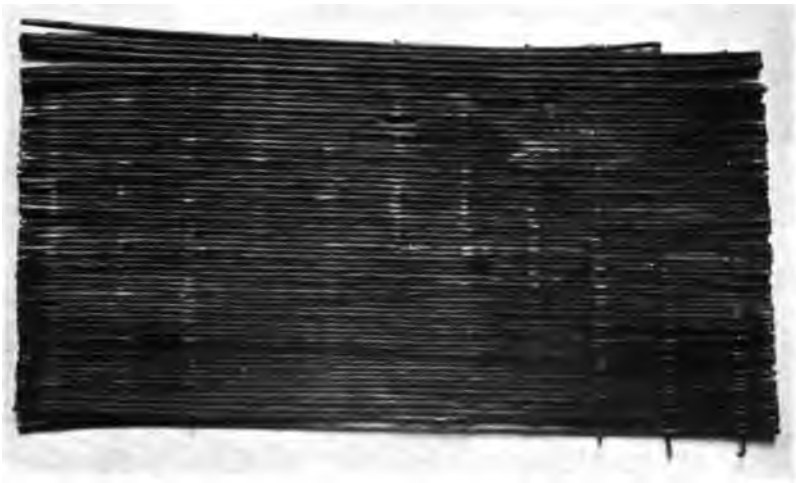

FIG. 61.—Mat made of sticks found with a skeleton in room west of kiva D. Photograph by De Lancey Gill.

FIG. 62.—Pottery rest made of agave fibre core wound with feathered string.

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ruin was taken a shard with a fine swastika, showing the antiquity of this design so rarely found in Mesa Verde.

The general facies of the collection of artifacts from Square Tower House is the same as in other cliff dwellings on the park, and although a few specimens are different from those already known, the majority corroborate, as far as age is concerned, the testimony of the buildings. A broken fragment of the rim of a vase

FIG. 63.—Stick with carved extremity.

of the sugar bowl pattern, a type peculiar to the upper San Juan area, was obtained from the Unit-Type House. Fragments of food bowls corrugated on the outside, black and white on the interior, belong to a type hitherto rare. No collector has thus far reported a prehistoric pipe from Mesa Verde, but a stumpy straight tube of unburnt clay, more like a "cloud blower" than a pipe, betrayed the fact that the cliff dwellers, like other Indians, smoked ceremonially.

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On their altar at the great winter solstice ceremony at Walpi, one object of which is the increase of life by calling back the sun, the Hopi now employ an idol representing the god of germination. This idol is half oval in shape, the surface being painted with symbols of corn. A similar undecorated idol (fig. 60), found at Square Tower House, one of the best ever collected, was cemented by the author in a conspicuous place at the head of the stairway.

An almost perfect reed mat (fig. 61), resembling those often deposited with the dead, was found in a room of Square Tower House. Good specimens of feathered cloth were wrapped around skeletons of infants. A fine pottery rest (fig. 62), and a stick which

FIG. 64.—Incised maze on one side of an artificially worked cubical stone found with idol of the germ-god. The dotted line does not exist on the specimen, but was placed there to enable the reader to trace the meander. Photograph by T. G. Lemmon.

shows excellent carving on one end (fig. 63), occur in the collection; there are also many bone needles, basket fragments, and other objects similar to those elsewhere described.

A cubical stone with an incised design (fig. 64) found in the same room as the idol of the germ god, is worthy of special mention as the maze or labyrinth depicted upon it is unlike any pictograph yet described from the Southwest.

Theoretically, Earth Lodge A is supposed to resemble forms of dwellings that have survived to our day among non-pueblo tribes.

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It has, however, an instructive feature they do not possess, viz., cists made of slabs of stone set on edge. Evidences are accumulating of a culture antecedent to the pure pueblo type in which vertical masonry predominates, but we must await more knowledge of the construction of the houses of this epoch before speculating on the early relations of the builders of vertical and horizontal masonry.

FIG. 65.—Square Tower House repaired, as seen from the west. Photograph by T. G. Lemmon.

ARCHEOLOGICAL EXCAVATIONS IN ARIZONA

In continuation of work in Arizona for the Bureau of American Ethnology, Dr. Walter Hough began excavation of an important ruin in Grasshopper Valley, 14 miles west of Cibecue on the White Mountain Apache Reservation, Arizona. The ruin consists of two great mounds covered with brush and showing portions of walls.

The inhabitants, as shown by the skeletal remains, were Pueblo Indians. Among the discoveries were a temporary camping place of a clan while their houses were being constructed; the use of heavy masonry retaining walls to prevent the thrust in the earth covered with the great structure of the pueblo; and the determination that the house plans, sometimes called " foundations," and thought to be unfinished structures, are remains of open air sheds, such as those now in use by the Pimas. The presence of two very large débris

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FIG. 66.—Retaining wall of ancient pueblo at Grasshopper Valley, Arizona.

FIG. 67.—Outlines of open-air sheds, ancient pueblos at Grasshopper Valley, Arizona.

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lenses, forming low mounds at 300 yards from the pueblo, is considered somewhat remarkable.

The artifacts consist of flint implements, stone axes, bone implements, and the usual variety of small objects. Of pottery, red and gray preponderate; also found are pure yellow (Hopi type); black outlined with white on strong red (Chevelon type); obscure yellow gray on brown with black designs (Gila type); and green glaze design on white (Rio Grande type). Analysis of the shards from the 20 excavations made show that the great ruin and the neighboring members of the group may be differentiated on the basis of the pottery fragments.

ARCHEOLOGICAL INVESTIGATIONS IN UTAH AND ARIZONA

Early in May, 1919, provision was made by the Bureau of American Ethnology for continuation of an archeological reconnoissance of northwestern Arizona, inaugurated several years ago, but interrupted by the recent world war. As in previous years, the work was directly in charge of Neil M. Judd, curator of American archeology, United States National Museum. Plans for an extensive survey of the arid regions immediately north of the Rio Colorado were necessarily abandoned because of the exceptionally dry season. Mr. Judd then proceeded to Cottonwood Canyon near Kanab, Utah, where, in 1915, he had hastily examined several shallow caves containing prehistoric remains.

As unforeseen conditions prevented completion of the reconnoissance originally contemplated, so unexpected difficulties also handicapped the Cottonwood Canyon investigations. Work continued during two weeks only, but in this short period twelve or more caves were visited and five of them were examined with considerable care. Most of the standing walls in these caves (fig. 68) were of the customary stone and mortar construction, but others were found in which adobe had been utilized almost exclusively. A third type of architecture was that in which the walls were formed of upright posts, bound together with horizontal willows and plastered over with adobe mud. In such dwellings the heavy roof was ordinarily supported by larger posts, placed as part of the wall or entirely within it. In these ruins (fig. 69) and in the remains of other houses which had preceded them, sandstone slabs were invariably utilized for the inner base of the walls, the remainder being either of stone and mud or wattled construction. Although dwellings of the three types above mentioned

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FIG. 68.—Isolated rooms forming part of a small cliff village in Cottonwood Canyon. Several of the rooms were repaired after excavation; the darker portions show the extent of these restorations.

FIG. 69.—At the upper left are the broken walls of dwellings built above the remains of a circular room. Fragments of wall posts and one roof support are shown at the right; the fireplace at the left. In the immediate foreground and in the middle of the view will be seen upright slabs which formed part of the lower inner wall.

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seem to indicate different stages in constructional experience, they could be and were found in the same cave. In such cases there was nothing to suggest any considerable lapse of time between the periods represented by the successive years of occupancy; neither could it be determined from the refuse in and about the dwellings that more than one people had taken part in their construction.

From the minor antiquities collected it does not appear that the degree of culture reached by the ancient inhabitants of Cottonwood Can-

FIG. 70.—Masonry walls built above the ruins of a circular kiva, previously destroyed by fire. The banquette or bench surrounding the room will be noted in the foreground; also, the charred fragments of several wall posts and one roof support.

yon differed essentially from that of other primitive peoples farther to the north.[1] The pottery, generally, is of a type closely related to the pre-Pueblo peoples south and east of the Rio Colorado, and indicates a higher degree of experience than that noted among the ruins at Beaver or Paragonah, for example. Wooden agricultural implements, basketry, cotton cloth and other objects commonly found in cliff ruins of the southwest are likewise of the well-known Pueblo type. The results of these recent excavations tend to confirm, therefore, the belief that in western Utah there is certain evidence of a prehistoric people which originated some place in the northwest and

[1] Smith. Misc. Coll., Vol. 66, No. 3, 1915; Vol. 66, No. 17, 1916; Vol. 68, No. 12, 1917.

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journeyed southward; that during the course of their long-continued migrations they changed rather rapidly from a semi-nomadic to a sedentary life as they approached the Rio Colorado. Having gained the "red rock" country and having found, for the first time, natural caves that increased the protection afforded by their small dwellings, they became more closely related, if not identical, in culture to those people commonly recognized as the ancestors of the modern Pueblo Indians.

FIG. 71.—Walls of rectangular dwellings built above the remains of a circular room. The upright slabs in the foreground formed the inner wall base of the latter structure.

FIELD WORK ON THE IROQUOIS OF NEW YORK AND CANADA

Mr. J. N. B. Hewitt left Washington May 12, 1919, on field duty. On the Onondaga reservation near Syracuse, N. Y., he found only fragmentary remnants of the League rituals, laws and chants, aggregating less than 2,000 native terms; but these rituals, laws and chants are so much broken and wasted away, and their several remaining parts are so confused and intermixed the one with the other that with these remains alone it would be quite impossible to obtain even an approximate view of their original content, forms, and settings. The texts which Mr. Hewitt has recorded among the Canadian Iroquois aggregate more than 125,000 native terms. During the two weeks spent on this reservation Mr. Hewitt recorded in Onondaga

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text all the doctrines of the great Seneca religious reformer of the close of the 18th century, Skanyodaiyo (the so-called "Handsome Lake," but which is literally "It is a beautiful Lake").

Mr. Hewitt left this Onondaga reservation May 31, 1919, going directly to the Grand River Grant, Ontario, Canada, where the other tribes of the six Iroquois tribes dwell. There he resumed his intensive study and analysis of his recorded texts relating to the institutions of the League, recording variant passages and terms when encountered. He also obtained in detail the pattern of the wampum strings in beads which are used in the Requickening Address of the League. Twenty-eight strings, at least, are necessary. On each string the blue and the white beads are arranged according to a definite pattern.

An effect of the war of the American revolution on the tribal integrity of the Six Nations of Iroquois was that every tribe, except the Mohawk, was sundered into two independent bodies; and one part of each of the divided tribes became resident on a separate reservation in the State of New York, and its public affairs became measurably dissociated from those of the parts of the other tribes dwelling in New York, while the complementary tribal parts removed to Canada, where they finally settled on the Grand River Grant. So that at first there were two Onondaga tribes, the one in New York and the other in Canada, two Seneca tribal groups, the one in New York and the other in Canada, two Oneida tribes, two Cayuga tribes, and two Tuscarora tribes, similarly dispersed.

This disrupting of tribal integrity resulted in sundering the League Federal Council into two independent units. Since the tribes in New York State severally occupied individual reservations, often far removed one from another, each tribe was thrown more on its own resources than previously; and the Federal Council composed of the New York tribes was convened only when some matter affecting all these tribes became urgent; and this situation naturally tended to efface the concrete knowledge of the basic federal laws and principles of the League from the minds of the New York tribes, so that within 50 or 60 years after this, the laws and the rituals of the original League had become largely obsolescent, if not wholly forgotten, in New York State.

Conversely, the tribes of the Six Nations of Iroquois who removed to Canada and settling on the Grand River Grant elected to transact their affairs at a semi-federal council composed of all tribal and all federal chiefs (whose titles were not then held in New York State).

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This arrangement naturally tended strongly to preserve the traditional and the concrete knowledge of the distinctively federal institutions and laws and rituals. But, even here, a living and constructive knowledge of the institutions of the League is less definite and is often displaced by dubious modern interpretations. So it has become increasingly difficult, indeed, to obtain from the variant extant versions of laws, traditions, rituals, songs and institutions, their most probable original form.

The Onondaga tribes of New York State, dwelling 8 miles southward from Syracuse, occupy the ancient seat of the Federal Council of the League of the Iroquois. In the original structure of the League, and still exercised by both the Canadian and the New York federations, the Onondaga chiefs as a body exercised functions approximating those of the presiding judge of a modern court sitting without a jury, and had power to confirm or to refer back (but not to veto) for constitutional reasons the decisions or votes of the Federal Council.

OSAGE TRIBAL RITES, OKLAHOMA

In the spring of 1919 Mr. Francis LaFlesche, Ethnologist, spent a month among the Osage Indians, gathering further information concerning the ancient rites of that tribe and collected two rituals, one from Wa-tsé-mo^{n}-i^{n}, pertaining to the origin of the people of the black bear gens, and one from Mo^{n}-zho^{n}-á-ki-da of the Peace gens of the Tsi'-zhu division, as to the origin of that people.

The ritual obtained from Wa-tsé-mo^{n}-i^{n} contains 582 lines, divided into 29 sections and arranged in groups according to subjects. The first group of five sections describes the descent of the people from the sky to the earth. The second group of four sections tells of the appeal of the people to certain water insects who promise help. The third group of eight sections speak of the Great Elk who brought to light four different colored soils which he gave to the people to use in this rite as symbols. The next group of a single section tells of the wanderings of the people, of their meeting a man whom they learned had descended from the stars and who gave to the people certain sacred gentile names. Although they were warriors whose business it was to destroy, they resolved to make the stranger their chief, saying to one another: "There shall be in him no anger, no violence and he shall be a man of peace."

The fifth group of three sections speaks of the parts of the swan that were dedicated for use as a war standard. From this sacred bird were taken personal names. The sixth group of four sections

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recounts the finding of four different kinds of rock in their consecration for symbolic purposes. The seventh, a single section, speaks of the finding of a female buffalo, the consecration of parts of its body

FIG. 72.—Wa-tsé-mo^{n}-i^{a}. Member of the Black Bear Gens.

and skin for ceremonial purposes. The eighth group of three sections recounts the search for a suitable kind of stone out of which to make a ceremonial knife. On his third search the man chosen for

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the duty returned with a red flint out of which was shaped a round-handled knife and consecrated to ceremonial uses.

The ritual given by Mo^{n}-zho^{n}-á-ki-da contains 248 lines, divided into 20 sections and arranged, according to subjects, into eight groups. In the story told by Mo^{n}-zho^{n}-á-ki-da the people of the Peace-maker gens awakened in mid-heaven to a realization that they were a people when a desire came upon them to descend to earth where they might come into bodily existence. The first three sections record the downward journey, of the people finding the first and second heavens (counting downward) to be blank, but in the third heaven they met the Man-of-mystery (the god of rain), who promised them aid in their struggles upon the earth. The sixth section tells of the further descent of the people, of their meeting the great Buffalo Bull who, out of pity, gives them certain roots to use in healing their bodily ailments. These medicinal roots are used to this day. The great animal then gave them various kinds of corn and squash. The five sections following speak of the journey of the people over the earth, of their coming to certain trees, to the waters of a river where they met the spirit of waters, to water-plants each of which they adopt as life-symbols. The next, a single section, tells of the coming of the people to a dead animal which they adopt as a symbol. The significance of the incident is not clear. In the next two sections is told of the people coming to the center of the earth, meaning mid-summer, the time greatest in fruitfulness (August), and to a "beautiful house" which was to be their sanctuary. The next group is a single section and speaks of the encounter of the people with another dead animal (an elk), the meaning of which is not clear. The next two sections speak of the people again coming to the center of the earth, meaning another month (September), which, together with August, makes mid-summer. The people at last reach another "beautiful house" with many openings, wherein are to be sent all the children of the people to be given their gentile personal names and assigned to their proper places in the tribal and gentile order.

ETHNOLOGICAL STUDIES IN OKLAHOMA, NEW MEXICO, AND CALIFORNIA

The year was spent by Mr. J. P. Harrington, ethnologist, in continuation of his studies of Southwest Indian languages and ethnology. During the first five months of the calendar year he was engaged in the study of the Ventureño and other Chumashan dialects of California. Especial attention was given to the ethnology as well as to the language, the linguistic studies proving to be the key to the

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unearthing of considerable important ethnological data, notably on subjects pertaining to material culture, sociology, and the little habits of daily life and thought which are really fully as important as the larger and more striking features of ethnology.

FIG. 73.—Ventureño Man.

The months of July, August and September were spent in New Mexico in study of the Tano-Kiowan problem, and with as conclusive and gratifying results as could be desired. The entire struc-

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ture and vocabulary of Tanoan and Kiowa is one and the same, and points to genetic unity at no exceedingly remote period in the past. A peculiar series of phonetic shifts and changes occurring in these languages was fully investigated, and interesting studies in comparative vocabulary were made.

FIG. 74.—Hoop and pole game of the Ventureño Indians.

MUSIC OF THE PAWNEE, OKLAHOMA

In May, 1919, Miss Frances Densmore went to Pawnee, Oklahoma, to begin a study of the music of the Pawnee Indians who live in that vicinity.

She arrived at the time of the Buffalo ceremony which is held every spring by the Pawnee, having for its original purpose the securing of buffalo for food. The ceremony was held in an earth lodge of the old type (figs. 75 and 76). Only initiates could be present on the first day when the "painting of the buffalo skull" took place, but, through the courtesy of the man in charge of the ceremony, Miss Densmore attended the Buffalo dance and the Lance dance which were held a few days later. These constituted the second and third portions of the ceremony. During the Buffalo dance the buffalo skull with its ceremonial decorations lay in front of the "altar." Participants in the ceremony were seated in four groups, men in each group having their bodies similarly decorated with symbolic designs. The principal singer was Wicita Blain, a

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blind man, who at a subsequent time recorded a number of the songs used on this occasion. These were old songs which he had received by inheritance, and the words contain interesting examples of native poetry. Blain also recorded ceremonial songs of the Bear dance, which were his by right of inheritance.

One of the leading participants in the Lance dance was John Luwak, chief of the Chaui band (fig. 77), who recorded numerous old songs of various classes. Some unusually attractive songs were heard during the Lance dance, but it was learned on inquiry that they

FIG. 75.—Pawnee ceremonial earth lodge. Photograph by Miss Densmore.

had been recently composed by the younger men of the tribe. As old songs were desired these were not recorded. One of the old Lance dance songs was obtained, with the words, "Father, the band of the dead is coming." This was sung when the lance bearers danced around the lodge. The study was limited to the music, no study of the ceremonies being undertaken at this time.

Three other gatherings were attended by Miss Densmore, *i. e.*, a hand game and two victory dances.

The victory dances were of unusual interest as they celebrated the return of young men who had served in the recent war. Forty Pawnee enlisted; 39 returned without having suffered any casualty, and one died of disease in France. Many of the men had been at the front, several volunteered for a certain duty of special danger, the

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son of a chief served with the heavy artillery in a responsible position, and wherever opportunity offered, they seemed to have made a creditable record. All appeared to be in the best of health. A member of the tribe said he "believed this was because the people had prayed for them, both in private and at all their public gatherings." The first victory dance was the occasion of the public rejoicing of the women of the tribe, especially those whose relatives had been in the war. This was similar to the scalp dances of the old times, and about 40 women were in the dancing circle. War trophies were carried aloft on poles, as scalps were formerly carried. In accordance with old custom the soldiers presented their trophies to their nearest kinswomen. One woman held a pole with a long knife fastened at the end like the head of a spear, while below the knife was hung the metal helmet which, with the knife, was taken from the enemy by her son. As the women danced they lifted their trophies high in the air, and expressed their enthusiasm in shrill cries. It was a scene of free, native rejoicing. Miss Densmore was the only white person present. Many war songs were sung, former deeds of valor were related by the old warriors and the dancing continued for several hours. The Pawnee are an emotional people, and some of the older members of the tribe lamented with sobs and crying the diminution of the tribe and the passing of the old ways.

The second victory dance took place several days later and was entirely different in character. Many spectators attended, and the building was crowded to its utmost capacity. At this dance the returned soldiers were the principal interest, many appearing in native costume and dancing the war dance. One such young man told Miss Densmore that he had been at a government school practically all his life and never before had joined in a native dance. The gathering opened with an impressive native ceremony, then speeches were made by the chiefs of the bands, gifts were given and received in a ceremonial manner, and the son of a chief was adopted by a prominent member of the tribe, receiving an old and honored name. The young man went through the simple ceremony with quiet dignity, wearing the khaki uniform in which he had served in Europe. Once the space around the entrance was cleared and a woman led in a white horse, presenting it to a soldier; later a pair of white horses were similarly presented. An interesting little drama was the "consoling" of the parents of the young man who died in France.

The singing at the victory dances was characterized by songs with words concerning the recent war, including mention of airplanes.

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submarines and the enemies of the allied nations. These words were usually sung to old melodies. One woman advanced alone to a place in front of the chiefs and, without the drum, sang such a song which she had composed for the occasion. Two similar songs were recorded by Luwak who related the dreams in which he heard them. He said he "prayed daily to Tirawahat," saying, "help our boys over there so they will all come back strong and so I may live to see them again." One night he fell asleep after such a prayer and in his sleep "someone told him that it would not be long before he would see the Pawnee boys again." In his dream he saw thousands of white people

FIG. 76.—Pawnee ceremonial earth lodge, interior, showing location of the "altar." Photograph by Miss Densmore.

rejoicing and heard them singing this song, "even the oldest people were dancing and waving flags." A few days later he heard of the signing of the armistice, with its celebration, and accepted it as the fulfilment of his dream. He related the dream and sang the song at a gathering opened with an impressive native ceremony, then speeches learned by the people.

MATERIAL CULTURE OF THE CHIPPEWA OF CANADA

In July, 1919, Miss Densmore visited the Manitou Rapids Reserve in Ontario, Canada, through the courtesy of Mr. J. P. Wright, Indian agent at Fort Frances, Ontario. Chippewa from other localities in Ontario were also interviewed. The purpose of this trip was to

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FIG. 77.—John Luwak, chief of the Chaui band, Pawnee.

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obtain data on the bead patterns, use of native dyes, medicinal herbs and other phases of material culture among the Canadian Chippewa for comparison with similar data already collected among the Chippewa of Minnesota. Numerous old geometrical bead patterns were noted which show an entirely different character from those in use among the Minnesota Chippewa, and only two patterns were duplicated. An interesting observation on native dyes consisted in the use of a bright green dye made from four plants. Specimens of three of these plants were obtained, but the fourth grew at a considerable distance. A birchbark article decorated with roots colored with the dye was also obtained. Green vegetable dye is not known among the Minnesota Chippewa, so far as the present inquiry has extended. The simpler medicinal herbs are the same as among the Chippewa of Minnesota, but interesting variants of general customs were observed.

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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 72, NUMBER 6

EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1920

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Cascade Mt. (9,825′)

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1920

INTRODUCTION

Investigation of the unexplored regions of the earth and extending scientific knowledge of imperfectly known localities have from the beginning been an important phase of the Institution's activity in the "increase of knowledge." This pamphlet serves as an announcement of the more important expeditions sent out during the calendar year 1920, and more detailed accounts of the scientific results are later published in the Proceedings of the U. S. National Museum, Bulletins of the Bureau of American Ethnology, and other series of publications issued under the direction of the Institution.

Not only has our knowledge of little known regions been increased through the numerous expeditions sent out by the Institution during the 75 years of its existence, but also the collections in natural history and anthropology in the Museum have been greatly enriched thereby. The urgency of some of the field-work is illustrated by the Australian expedition herein briefly described. The remarkable Australian mammal life has been but meagerly represented in the National Museum and the rapid extermination of the native animals through various agencies renders increasingly difficult the securing of an adequate collection. However very satisfactory shipments are being received from the present expedition and it is hoped that a good representation will be secured for the Museum before it is too late.

GEOLOGICAL EXPLORATIONS IN THE CANADIAN ROCKIES

During the field season of 1920, geological exploration was continued by Secretary Charles D. Walcott in the Canadian Rocky Mountains, with two main points in view, (1) the determination of the character and extent of the great interval of non-deposition of sedimentary rock-forming material along the Front Range of the Rockies west of Calgary, Alberta; (2) the clearing up of the relations of the summit and base of the great Glacier Lake section of 1919[1] to the geological formations above and below. The party going from Washington consisted of Dr. and Mrs. Walcott and Arthur Brown.

[1] Smithsonian Misc. Coll., Vol. 72, No. 1, 1920, p. 15.

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FIG. 2.—Cliffs rising above the northern shore of the head of Lake Minnewanka. Photograph by C. D. Walcott, 1920.

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FIG. 3.—Eastward facing cliffs above Ghost River on the Rocky Mountain front. The Ghost River formation is on top of the great lower cliff, and the Devonian limestones in the broken cliffs above. Photograph by C. D. Walcott, 1920.

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FIG. 4.—A great headland on the north side of Ghost River, which flows out of the mountain through a broad U-shaped canyon valley. Photograph by C. D. Walcott, 1920.

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Early in July work was begun along Ghost River northeast of Banff and about 53 miles (85 km.) west of Calgary, Alberta. The route taken was along the north shore of Lake Minnewanka (fig. 1, Frontispiece) and through the Devils Gap to Ghost River, which here runs north and south at the foot of high eastward-facing cliffs of Cambrian limestone, capped by limestones of Devonian age. Lake Minnewanka is a beautiful sheet of water (fig. 2) in the broad bottom of a pre-glacial river channel, the eastward extension of which forms the Devils Gap.

The Rocky Mountain front (fig. 3) is formed of masses of evenly bedded limestone that have been pushed eastward over the softer rocks of the Cretaceous plains-forming rocks. This overthrust is many miles in extent and occurred long ago before the Devils Gap,

FIG. 5.—Devils Head (9,204 ft.), a butte rising above the cliffs of Fig. 3 on the north side of Ghost River Gap. Photograph by C. D. Walcott, 1920.

Ghost River Gap and other openings were cut through the cliffs by running water and rivers of ice. Great headlands (fig. 4) and high buttes (fig. 5) have been formed by the silent forces of water and frost, many of which stand out against the western sky as seen from the distant foothills and plains.

It was among these cliffs that we found that the first great cliff (figs. 3 and 4) was of lower Middle Cambrian age, and that resting on its upper surface there were 285 feet (86 m.) of a yellowish weathering magnesian limestone, here named the Ghost River formation, which represents the great lost interval between the Cambrian below and the Devonian above. Sixty miles to the west, over four miles in thickness of limestone, shales and sandstones (22,670 feet (6,890 m.)), occur in the lost interval of the Ghost River cliffs.

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FIG. 6.—Western side of cliffs at the eastern end of upper valley of Clearwater River, 22 miles north of Lake Louise Station. The Devonian limestones cap the ridge on the right with Ordovician rocks beneath and Upper Cambrian in the lower cliff. Photograph by C. D. Walcott, 1920.

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FIG. 7.—A contented outfit on a Sunday afternoon near the head of the Clearwater River. Photograph by C. D. Walcott, 1920.

FIG. 8.—Photographing far above timber line (9,400 ft.) over Pipestone Pass. Photograph by Mrs. Mary V. Walcott, 1920.

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FIG. 9.—Result of an hour's fishing in Lake Minnewanka near Banff. Photograph by Mrs. Mary V. Walcott, 1920.

FIG. 10.—The avalanche lily forces its way up through the hard snow, and its beautiful slender green leaves and yellow flowers fairly cover the thin outlying margins of the winter's snow. Photograph by Mrs. Mary V. Walcott, 1920.

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FIG. 11.—Our pack horse "Pinto" preferred to take a short cut at the ford and went down in deep water and was dragged out. Getting ready to get her up. Photograph by Mrs. Mary V. Walcott, 1920.

FIG. 12.—Getting "Pinto" up on her feet in shallow water. Photograph by Mrs. Mary V. Walcott, 1920.

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Returning to the Bow Valley, the party left the Canadian Pacific Railroad at Lake Louise and went north over Pipestone Pass to the Siffleur River, which is tributary to the Saskatchewan. In the northward-facing cliffs 25 miles (40 km.) east of the Glacier Lake section of 1919, and 40 miles (64 km.) north of Lake Louise, a geological section was studied that tied in the base of the Glacier Lake section of 1919 with the Middle and Lower Cambrian formations. Returning up the canyon valley of the Siffleur River to the wide upper valley of the Clearwater River, a most perfectly exposed series of limestones, shales, and sandstones of Upper Cambrian and later formations was found (fig. 6) which cleared up the relations of the upper portion of the Glacier Lake section to the Ordovician formations above.

The field season was marred by forest fire smoke in July and August, and almost continuously stormy weather in September. Some of the incidents of the trail are illustrated by figures 7-12. The trout of Lake Minnewanka (fig. 9) increased our food supply for days while on Ghost River, and the camp on the Clearwater was a paradise for man and beast (fig. 7). On Pipestone Pass the avalanch lily was found forcing its way up through the hard snow (fig. 10), and in a treacherous ford of the Pipestone River, Arthur's war bag and the sugar and flour got a soaking.

The party is indebted in many ways to the officials of the Rocky Mountains Park, and to the officials of the Canadian Pacific Railroad, all of whom gave assistance whenever it was possible to do so.

GEOLOGICAL FIELD-WORK IN THE UNITED STATES

Dr. R. S. Bassler, Curator of Paleontology, U. S. National Museum, was engaged in field-work in Ohio and Illinois during the latter half of June and the first part of July, with the result that two large, instructive exhibits and important additions to the study series of fossil invertebrates were obtained. Proceeding first to Northside, Ohio, Dr. Bassler made arrangements for the shipment to Washington of a large, well-preserved fossil elephant skull which had been purchased by the Museum through the efforts of Dr. E. O. Ulrich, Associate in Paleontology. This specimen, discovered in glacial gravels near Cincinnati some years ago, was long the prize exhibit of a local saloon; in fact, it was so highly regarded for advertising purposes that repeated offers of a considerable sum for its purchase were invariably refused. With the coming of prohibition, its former usefulness departed and the Museum was able to secure it for a

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nominal amount. Teeth of this species (*Elephas columbi* Falconer) are contained in our collections, but such a complete skull is of rare occurrence, there being only one or two others in North American museums. The specimen is further valuable in giving evidence as to the proper position of the tusks in the skull, a subject of long controversy.

The second important exhibit secured during the trip was a slab, measuring four by eight feet, of highly fossiliferous limestone from the Richmond formation of Early Silurian age as exposed near

FIG. 13.—Beginning of excavation for exhibition slab of Richmond limestone near Oxford, Ohio. Photograph by Bassler.

Oxford, Ohio. Such a specimen had long been desired for the exhibition halls to show the advancement in life from the primitive Cambrian forms, represented in the large Cambrian sea-beach sandstone exhibit, to the higher and more complex species of succeeding geological periods, but notwithstanding the numerous occurrences of fossiliferous limestone of Ordovician and Silurian age, it was not until 1920 that a layer affording slabs of suitable size and sufficient perfection of preservation was brought to the attention of the Museum. This was discovered by Dr. W. H. Shideler, Professor

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of Geology at Miami University, Oxford, Ohio, who most generously assisted in quarrying out the specimen. As shown in the accompanying photograph (fig. 13) representing the beginning of the excavation for the thin bedded, fossiliferous layer desired (marked *x*), numerous large blocks of stone had to be removed before the real task of quarrying the slab was begun. The work was completed successfully and the exhibit is now being installed in the hall of invertebrate paleontology. The perfection of the fossil shell remains on this slab

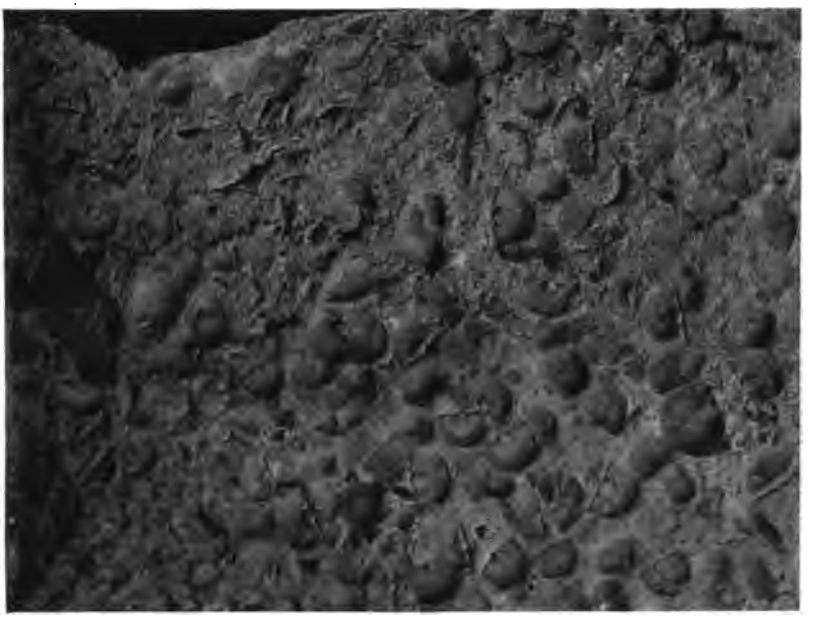

FIG. 14.—Surface of fossiliferous limestone slab, one twenty-fifth natural size. Photograph by Bassler.

is evidenced in figure 14, which, however, shows only in a small degree the distinctness of the shells upon the rock background.

Upon the completion of the quarrying operations at Oxford, Dr. Bassler proceeded to Chicago, Illinois, where he was engaged in the preparation of casts of type specimens of fossils contained in the collections of the Walker Museum, University of Chicago. The paleontological collection of the National Museum, which includes the celebrated Walcott, Ulrich, Springer, Harris, Nettelroth, and Rominger collections, is especially rich in type specimens of Early Paleozoic fossils, but nevertheless the Walker Museum possesses

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many unique types not represented at all in Washington. Permission to prepare casts of these and thus advance our study series toward the completeness which the National collections should attain, was generously granted by Dr. Stuart Weller, Director of the Walker Museum. In two weeks time Dr. Bassler was enabled to finish casting all of the Ordovician and Silurian types, leaving the remaining Paleozoic species for a future trip. The work was done quickly by using the modeling compound (plastocene) to make the mold from which the cast is prepared. After dusting the fossil with talcum powder the modeling compound is carefully pressed upon it and then withdrawn, thus securing a clear-cut impression into which the plaster is poured. Bubbles can be avoided by first pouring thin plaster of Paris into the mold and distributing it uniformly with a camel's hair brush. The thicker plaster is then introduced as usual to fill the cavity. When dry the modeling compound is torn away, thus leaving the complete cast but also, unfortunately, destroying the mold.

Field-work in vertebrate paleontology was limited to a short trip made by Mr. J. W. Gidley, Assistant Curator, in the latter part of August to Williamsburg, Virginia, where scattered remains of a fossil whale had been found in the Miocene strata outcropping nearby. It was at first hoped that an entire skeleton could be secured here, but careful search proved the bones to be so scattered and fragmentary that no exhibition material was available although some interesting additions to the collection of fossil vertebrates and some excellent Miocene shells for the exhibition series were obtained.

Mr. William F. Foshag, of the Division of Mineralogy, at his own expense made sundry trips into interesting mineral localities in California and secured a considerable quantity of desirable material for the Museum's collections, including an excellent series of borax minerals.

FIELD-WORK IN ASTROPHYSICS

In astrophysical research the Institution was unusually active. Early in 1920, Dr. Abbot had a long discussion and correspondence with Professor Marvin, Chief of the United States Weather Bureau, on the applications of solar radiation measurements to meteorology now being officially practised in Argentina and Brazil on a basis of daily telegraphic reports from the Smithsonian observatory near Calama, Chile. Professor Marvin felt strongly the inadequacy of existing solar radiation observations as a basis for studies of the dependence of temperature on the solar variation. While the Chilean results might be excellent, still they were for the most part not

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checked by independent observations. The Mount Wilson work yielded results on less than a third of the days, and might well be affected by variations of atmospheric humidity incident to the site so near the Pacific Ocean and the cities about Los Angeles. These objections could not but be admitted by Dr. Abbot, and led him to make a great effort to strengthen the observations of solar variation.

Mr. John A. Roebling, of New Jersey, had indicated a strong interest in the work. In conference with Dr. Abbot in May, 1920, he generously gave the sum of eleven thousand dollars for the purposes

FIG. 15.—Montezuma solar observing station near Calama, Chile. Dwelling house, shop and garage.

FIG. 16.—Montezuma solar observing station. Entrance to spectrobolometer tunnel. Also pyrheliometric apparatus.

first, of removing the station theretofore on the plateau near Calama, Chile, to a nearby mountain high enough above the plain to avoid dust and smoke; second, of removing the "solar constant" outfit from Mt. Wilson to the best mountain site available in the United States; third, the balance for any other objects closely associated with these investigations.

Under the zealous and able management of Director A. F. Moore, a new observing station was selected and prepared at a place called Montezuma, about 8 miles south of Calama on a mountain rising about 2,000 feet above the local level, and about 9,500 feet above sea

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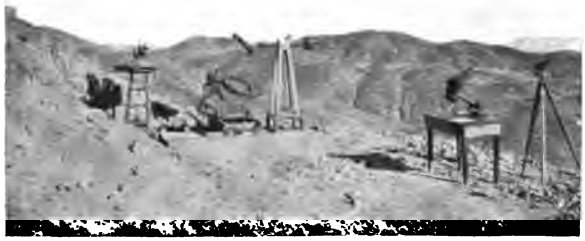

FIG. 17.—Montezuma solar observing station. Coelostat and pyrheliometric apparatus.

FIG. 18.—Montezuma solar observing station. The peak on which the observatory is located.

FIG. 19.—Hauling materials from Calama for the solar observing station at Montezuma.

FIG. 20.—Solar observing station at Montezuma. Dwelling house.

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FIG. 21.—Town of Wenden, Arizona. Mt. Harqua Hala in the background.

FIG. 22.—Packing apparatus to Mt. Harqua Hala.

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level. The instruments are arranged in a tunnel excavated horizontally in solid rock near the summit of the mountain. Observers' quarters, computing rooms, garage and shop are located some three hundred feet lower in a sheltered ravine. These quarters can be reached by the auto truck in 50 minutes drive from Calama. No road had to be constructed, as there are no trees in the region, and a way was found smooth enough, and of sufficiently easy grade, without working. Within about two months of receipt of the Institution's telegram, Mr. Moore completed these arrangements, removed the

FIG. 23.—Observatory on Mt. Harqua Hala.

outfit from its former location and recommenced observing August 5, 1920, at Montezuma with the loss of but ten days for the removal. He regards the new site as excellent, and expresses doubt if a better one could be found in the whole world.

In December, Mr. Moore returned to the United States, turning over the Directorship of the Chile Station to Mr. Leonard H. Abbot, formerly assistant, who is now assisted by Mr. Paul Greeley. Telegrams giving the values of solar radiation observed are sent as heretofore to Buenos Aires and forwarded from there to Rio de

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Janeiro. Both the Argentine and Brazilian Weather Bureaus employ them with approval for forecasting purposes.

Dr. Abbot, with the advice and assistance of the U. S. Weather Bureau, which carried on special observations in several localities for the purpose, selected a site on Mount Harqua Hala, near Wenden, Arizona, as the best place to relocate the Mount Wilson outfit. A building, partly underground, was erected there in July and August by local contractors. Messrs. Abbot and Aldrich occupied the Mount Wilson Station as usual from July 1 to September 15, when the outfit

FIG. 24.—Coelostat and pyrheliometer, Mt. Harqua Hala.

was removed to Mount Harqua Hala, where observations were begun on October 2, 1920. Dr. Abbot took charge and continued observing until January 25, 1921, assisted by Mr. Fred A. Greeley. Mr. Aldrich then relieved Dr. Abbot, and it is expected will himself be succeeded about May 1, 1921, by Mr. A. F. Moore, formerly at Calama.

Thus the Institution has now in charge two first-class solar radiation observatories, which are to be operated continuously hereafter until the question of the value of the solar variation as a meteorological datum is definitely settled. Heretofore the measurements have

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been secured on nearly 70 per cent of the days at Harqua Hala and on nearly 80 per cent at Montezuma. The agreement of results on days in common has hitherto been remarkably close and leads to the hope of surely detecting solar variations as small as 1 per cent.

The conditions of living at Montezuma, while lonely, are not excessively so. Frequent motor trips to the city of Calama for supplies, and occasional visits to the copper mine at Chuquicamata, where great kindness is experienced, help to break the monotony. At Mount Harqua Hala, however, the isolation is excessive. There

FIG. 25.—Top of Mt. Harqua Hala after a snowstorm, showing fog-bank in the background.

is a single neighbor, Mr. Ellison, a mining prospector located a mile away, on whose three burros depends the transportation for the observatory. It is 11 miles from Wenden to the foot of the mountain trail, which is 5 miles more in rising about 3,000 feet. Mail is received only about once in two weeks, when supplies are ordered by heliograph signaling with Morse code to the merchants in Wenden, at the cost of several hours hard work with the lights. Water must be hauled from Mr. Ellison's camp, over a mile distant and 850 feet below, except when at rare intervals rain falls. The two observers

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cook, wash, cut firewood from the small oak bushes and dwarf yuccas about, and repair or alter the building or the apparatus as occasion requires, besides carrying on the solar investigation.

During the occupation of Mount Wilson in 1920, many pieces of research were successfully carried through by Messrs. Abbot and Aldrich besides the measurements of solar variation. One of the most interesting was the perfecting of the solar cooker begun several years ago. A parabolic cylindrical mirror with polished aluminum surface of about 100 square feet focuses the sun's rays upon a blackened tube filled with mineral oil communicating to an iron

FIG. 26.—Solar cooker on Mt. Wilson.

reservoir of oil in which are two baking ovens. A continuous circulation of the heated oil keeps the ovens hot enough to perform all cooking operations except frying. Excellent bread, meat dishes, vegetables, cereals, canned fruits and vegetables and preserves were cooked there by Mrs. Abbot, who had charge of this part of the experiments and who was much envied for her cool kitchen and novel appliance by the ladies of the mountain. This solar cooker was constructed on Dr. Abbot's plans largely at the cost of grants from the American Academy of Arts and Sciences in Boston, and the National Academy of Sciences. It has proved successful, but must be regarded

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at least for the present as rather a luxury for rural and relatively cloudless regions, than as a generally useful appliance.

ZOOLOGICAL EXPLORATION IN AFRICA

The generosity of friends of the Smithsonian Institution made it possible to engage Mr. H. C. Raven, well known for his previous

FIG. 27.—The Chimpanzee was one of the most interesting animals in the forest. Their calling and shouting could frequently be heard early in the mornings and on moonlight nights. Adult female, Uganda, July, 1920.

work in Borneo and Celebes, to accompany the " Smithsonian African Expedition, under the direction of Edmund Heller in conjunction with the Universal Film Manufacturing Co.," which sailed from Brooklyn, July 16, 1919, on the steamship City of Benares, and arrived in Cape Town, August 13.

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FIG. 28.—A fine leopard secured at Masindi, in Uganda, by jacking, June, 1920.

FIG. 29.—The large gray and black civet is a beautiful animal which is seldom seen owing to its nocturnal habits. Budongo Forest, June, 1920.

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FIG. 30.—One of the specimens of *Genetta* collected during the time we were encamped on the Kafue River about sixty miles above its confluence with the Zambesi, in Northern Rhodesia, December, 1919.

FIG. 31.—The "standard-wing night jar." Masindi, Uganda, June, 1920.

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FIG. 32.—*Lates*, a large perch of Lake Tanganyika.

FIG. 33.—Kaffirs cleaning elephant skeletons at the camp of Major Pretorius, in the Addo Bush. The South African Government has ordered the destruction of these animals—the only herd of the kind in the world today, living so far beyond the confines of the tropics, with the exception of the few in the Knysna Forest. Kenkel Bosch, Cape Colony, September, 1919.

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FIG. 34.—Wahutu men dancing at Nyanza on the shore of Lake Tanganyika. Their voices, jingling bells on the ankles and stamping feet add excitement to the scene.

FIG. 35.—Among the Wahutu who live on the coast of the lake and the Watuzi of the mountains it is customary for a few of the best dancers to come forward that their skill in jumping and whirling may be demonstrated to better advantage.

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In the vicinity of Cape Town, Mr. Raven was able to collect only insects and invertebrates, and from there he went to the Addo Bush, where 19 days were spent in collecting small mammals and birds. Going through Durban and Johannesburg, Mr. Raven spent two weeks collecting at Ottoshoop in the Transvaal, after which he proceeded to Victoria Falls, and from there he left for the Kafue River

FIG. 36.—A young chief of the Wahutu ready to lead his men in the dance. Nyanza, Lake Tanganyika, February, 1920.

region, where he camped for several weeks. After spending some weeks along the Congo, he reached Lake Tanganyika, where camp was made for about a month. The next stop of any length was in Uganda, where a few days over a month were spent in collecting in the Budongo Forest. As the whole forest was in the sleeping-sickness area, it was necessary to get a special permit from the district commissioner to enter it, and the native boys had to be examined by a

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FIG. 37.—The Watuzi of the mountainous region northeast of Lake Tanganyika in one of their very picturesque dances. Each man carries a long lance or two, and a bow with one or more arrows.

FIG. 38.—Women of Liri on the Albert Nile repairing the wall of a hut with mud. The walls are made with wooden supports and between these are placed rows of stalks of elephant grass partly buried in the ground and fastened together with grass. The whole is then covered with mud and a roof built so that it overhangs and protects the walls from the erosive effect of rain.

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doctor before entering the area and again on leaving it. Work here was finished on July 14, 1920, after which Mr. Raven returned to the United States, sailing from Cairo, September 2, and arriving in New York, September 17.

FIG. 39.—A Dinka woman and her child at Shambe on the upper Nile. It is a rather common sight to see the natives cleaning their teeth with a bit of stick. Sometimes they pound the end or split it with a knife so that it becomes brushlike.

Though not numerically large the collections are of unusual interest on account of the manner in which they supplement those obtained by other expeditions in which the Smithsonian Institution has been interested. Among the most important material may be mentioned 697 mammals (including 272 specimens from South Africa, a region hitherto very imperfectly represented in our collections; 152 from

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FIG. 40.—The Victoria Falls of the Zambesi River. Above the falls the river is about a mile wide but drops over a cliff nearly four hundred feet into a narrow gorge which in some places is less than one hundred and fifty yards in width.

FIG. 41.—A native village at Port Bell in Uganda, with Lake Victoria Nyanza in the distance and to the right an acacia tree in which a colony of weaver birds have made their nests.

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FIG. 42.—Primitive irrigating machinery, on the Blue Nile at Khartoum, August, 1920. Oxen, donkeys or camels are used to turn such water wheels.

FIG. 43.—Sheep grazing near the temple of Medina Habu in Upper Egypt.

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Lake Tanganyika; the chimpanzee of Uganda), 567 birds, 206 reptiles, and 193 fishes. The photographs here reproduced were all taken by Mr. Raven, who has also prepared the legends which accompany them.

BOTANICAL COLLECTING IN AFRICA

Dr. H. L. Shantz, Botanist, Office of Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, was also a member of the Smithsonian African Expedition, and his chief objects were to secure live plants of agricultural value for introduction into the United States, to study the agricultural methods of both natives and Europeans, and to collect plants for the National Herbarium of the United States National Museum. This work began at Cape Town, August 13, 1919, and terminated at Port Said, September 2, 1920.

The vegetation of the Cape region has long been known to European botanists, and has received more attention than that of any other portion of Africa. It is difficult to imagine a region which has so many striking features. The wealth of Proteas and Ericas alone would make this region unique. Lilies of various and beautiful types, Iridaceae, Amaryllidaceae, and Orchidaceae, each represented by many genera and species, the Arum lily or calla, which occurs everywhere in wet soil, and Pelargoniums, which here cover the mountain sides, make of this Cape region a natural botanical garden, so rich and varied that any botanist will here find plants of absorbing interest. At Kirstanbosch there has been established the National Botanic Gardens now under the direction of Dr. R. H. Compton. If the well-laid plans are fully carried out, it will be possible to find here all of the more interesting indigenous plants of South Africa, and to this garden will come botanists, horticulturists, and agriculturists interested in South African plants. American botanists would be proud if we had anywhere in our country a garden to compare with it.

East of Port Elizabeth in the Addo Bush, which is a low thorn thicket of trees and vines about 15 to 20 feet high, are food plants of especial interest. Among the succulents, none are more interesting than the speckbroom (*Portulacaria affra*), a source of forage for the wild elephant herd of the bush as well as for other large herbivora, ostriches, cattle, sheep, or other domesticated animals. This plant has been introduced into the United States and is doing especially well in southern California in the lower chaparral zone and should greatly improve the forage value of the natural range. Here are many interesting plants such as the picturesque *Acacia horrida,* with

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its large white spines, the Boer Bean, *Schotia speciosa,* the young beans of which are cooked and eaten, also many interesting Aloes, Lilies, Cotyledons, and Euphorbias. The elephants' foot (*Testudinaria elephantipes*) and many species of asparagus also occur here.

The Karroid plateau was seen only during the rest period, when its vegetation, which consists of desert grasses and shrubs, is in appearance identical with portions of the Great Basin in Nevada. Especially interesting features of this desert are the great number of species of

FIG. 44.—On the Karroid Plateau, west of De Aaar. This desert shrub, known as Karroo bush (Pentzia), is a valuable forage plant, resembling our bud sage of the Nevada and Utah deserts. Cattle, sheep and ostrich are the chief grazing animals.

Mesembryanthemum, several of which are edible, and the Karroo bush (Pentzia), a valuable forage plant, areas of which resemble in general appearance our Bud Sage areas of Nevada and Wyoming.

Passing northwest to the region about Kimberley, there is a scattered growth of Acacias, over an open desert grass type similar in some ways to the vegetation of west Texas and portions of Arizona and New Mexico. The high grasslands of the Transvaal, on the other hand, with a grass vegetation dominated by *Themeda forskalii,* reminds one of *Andropogon scoparius* areas in the drier portions of

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our prairies. Here corn is the principal crop and the large ranches with houses far apart, each with a clump of trees, make the resemblance to our prairies in the earlier days even more striking.

The portion of the Transvaal north of Pretoria, known as low Veld, consists of a scattered growth of relatively small trees over a grass cover composed of rather coarse tall grasses. This is one of the most widely distributed types and an exceptionally interesting one. The grasses are burned off each year and only such trees as can resist the fires can maintain themselves under this condition. This type becomes somewhat modified at Lourenço Marques, where the vegetation, although quite luxuriant, still showed signs of a prolonged drought period. Here, as in the region north of Pretoria, the Kaffir Orange (*Strychnos pungens*) is abundant, and there are many species of Acacia and Combretum. The Cashew Nut (*Anacardium occidentale*) is everywhere a prominent tree and has the appearance of being indigenous, although introduced from South America. It forms a large evergreen tree and is never cut down by the natives, who prize it both for the fruit and for the nut, from which they secure both food and a strong alcoholic beverage. Another tree of unusual interest is the Morula (*Sclerocarya caffra*), which has a valuable oil and edible nut, with a fruit useful for making jam and an alcoholic drink.

Of the more strikingly beautiful trees of this section are the red flowered and fernlike-leaved *Delonix regia,* the beautiful blue flowered Jacaranda, and the Mahogany Bean (*Pahudia quanzensis*) which produces in its large pods a large black bean with a brilliant scarlet cup-shaped aril at the base and is one of the important timber trees.

The vegetation at Salisbury reminds one of the low Veld above Pretoria, a grassland with scattered trees, singly or often in clumps. At Bulowayo the grasses are less luxuriant and the trees smaller and more xerophytic. The vegetation about Victoria Falls, except for the small forest irrigated by spray from the falls, is also xerophytic in character. At Kafue the grasses seem more luxuriant but the trees are much as at Victoria Falls. Here a number of important fruits were secured, most of which are still undetermined. A nut tree of unusual interest, because of its value for food and oil and the remarkably light weight of the wood, was secured here. It has been known as the Manketti Nut (*Ricinodendron rautanenii*). Here also occurs the Beobab (*Adansonia digitata*), the largest tree in Africa, useful to natives as a source of Bast fiber and as food. The acid white pulp which fills the fruit and surrounds the seed is eaten or dissolved in water to produce a refreshing drink.

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The dry, open forest around Elizabethville gives way, before Bukana is reached, to the tall grass and scattered trees which form the great Savanna, which surrounds the tropical forest of the Congo. The Lualaba is lined with oil palms (*Elaeis guineensis*) throughout almost the whole of its course, and during much of the time swamps of Papyrus are abundant along its course. Most interesting were the great numbers of wild Sorghum grasses, some of which may prove

FIG. 45.—Two large mango trees (Empe oribo) at Kigoma on Lake Tanganyika. The trees bear two crops of fruit a year, a large crop in January and February, and a small crop in August and September. The fruits are large, fully five inches long, of excellent flavor and with practically no fiber around the seed. The building in the back is the railway station.

valuable in our dry-land agriculture. The oil palm, which belongs to the native who planted it, is probably the most useful native plant in all Central Africa, and its oil is used by the natives as food and for making soap with which to wash their clothes.

The dense tropical forests which cover much of the central Congo were seen at Kindu on the Congo River, where they form a dense canopy, but where the undergrowth is not entirely shut out. At Kigoma and Ujiji, on Lake Tanganyika, the grassland is dotted with

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large mango trees, the fruit of which is large and of excellent quality. These trees were probably introduced by Arab slave dealers and

FIG. 46.—Watuzi chiefs dressed for the dance. They are, from left to right, Kikovio (son of Ararawe), Mizambo (a Bagamwa or prince of the fourth generation) and Ararawe (brother of the head chief, Andugu).

The dress consists of an undergarment of bark cloth, made from the bark of a fig tree, of two skins of leopard or serval cat, one over the shoulder and one around the loins. Each carries a long bow, decorated with banana fiber, two arrows and a long spear.

They live largely on cattle, and inhabit the high mountain grasslands of Urundi. They are exceedingly tall, slender and athletic men, are alert and pleasant and are almost untouched by white influence.

merchants, and probably all originated as seedlings. Along the shore of Tanganyika in Urundi many plants were collected. In the highland back of the lake at N'gano N'gano, the rolling hills are covered

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with excellent grasses of high forage value, and support thousands of cattle. The Watuzi who inhabit this region are one of the least known but most interesting tribes in all Africa. They are tall, slender, athletic men, with thin lips and straight noses, and are

FIG. 47.—A grove of cocoanut palms at Dar es Salam, Tanganyika Territory, with a native (Swahili) hut in the background.

The whole region about Dar es Salam and for fifteen or twenty miles inland is occupied by an almost continuous cocoanut palm grove. The notches in the trees facilitate the gathering of the nuts.

probably the best athletes in the world, especially at high jumping, which is one of their chief accomplishments. Many grasses and many bulbous plants from this region give promise of value as plant introductions. A great variety of bananas, beans, and cereals are grown by these natives.

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At Dar es Salam, a broad strip of coast is given over largely to the cultivation of the coconut palm, although the streets are often lined with wild figs, *Delonix regia,* and *Terminalia catappa.* Zanzibar is given very largely to the cultivation of cloves, and here are also grown many tropical fruits, and there is a small but exceedingly interesting botanical garden. Tanga is somewhat similar to Dar es Salam in vegetation.

FIG. 48.—Bank of the Victoria Nile at Masindi Port in Uganda. A luxuriant growth of papyrus, water-lilies, morning glories and other water plants. Much of Lake Kioga is covered with this type of vegetation.

While the vegetation of the north shore of Lake Victoria is rich and varied and reminds one of that seen in the Congo and on Lake Tanganyika, the outstanding features in Uganda are the areas of elephant grass, *Pennisetum purpureum,* and the immense tracts of bananas which extend for miles and miles, for bananas are relatively as important to Uganda as corn is to Illinois.

There are several small tropical forests in Uganda, and at Entebbe an unusually interesting botanical garden. The flame of the forest (*Spathodea*), a prominent tree through much of tropical Africa, the

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kidurii (*Antiaris toxicaria*), and many other trees are prominent here. At Entebbe one may see Para rubber, Cera rubber, Cacao, sugar cane, yams, corn, rice, wheat, and other temperate crops harvested at the same time.

The principal results of the expedition were the collection of about 1,000 botanical specimens for the National Museum, and the introduction of about 1,600 plants for growth as agricultural plants in this

FIG. 49.—The Uaso Nyiro River at Archer's Post. It flows through a semi-desert country abounding in big game animals. It is lined throughout by groves of Dum Palm.

country; the more important being forage plants, nut plants, fruits, and vegetables. The acquaintance was made of many men interested in plants and agriculture, throughout the Continent, who can be of service in connection with securing additional material. First-hand observations were made of the methods of agriculture pursued by African tribes as well as the Europeans, and a large number of photographs were taken which illustrate the natural vegetation and agricultural crop methods.

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AUSTRALIAN EXPEDITION

During the past year Mr. Charles M. Hoy has continued the work of collecting material in Australia, under about the same conditions as those mentioned in the last report on explorations. In this period collections were made at the following localities:

"Farina, S. A.: Work in the Farina district was done at Lindhurst, 30 miles east of the town of Farina. Nineteen days were spent there, resulting in the collection of 110 birds and 64 mammals. A few reptiles and insects were also collected."

"Kangaroo Island, S. A.: Twenty-six days were spent, in the field, on

FIG. 50.—Aboriginal grave yard, North Australia.

Kangaroo Island with the result of 85 mammals, 51 birds, and miscellaneous reptiles, amphibians, and marine specimens collected."

"Port Lincoln (Eyres Peninsula), S. A.: Twenty-two days were spent in the field resulting in the collection of 86 birds and but 15 mammals. A few miscellaneous specimens including reptiles, crustacea, etc., were also obtained."

"Busselton, W. A. (50 miles south): Camp was pitched 50 miles south of the town of Busselton, on the edge of the Government Timber Reserve. Forty days were spent in camp (May 14–June 23). The weather was the worst that I have experienced. During the whole 40 days, there were only three days free from rain. Over 18 inches fell in that time. It was impossible to keep things dry and even the tent fly went green with mould. Despite these handicaps, however, a pretty fair collection was obtained. The collection contains 94 mammals, 46 birds and a few miscellaneous alcoholic specimens (reptiles and land shells)."

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FIG. 51.—A rufous rat-kangaroo from New South Wales.

FIG. 52.—Phascogale, a mouse-like marsupial from New South Wales.

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FIG. 53.—A young kangaroo. Photographed on Kangaroo Island, Australia.

FIG. 54.—An Echidna or "spiny anteater" photographed on Kangaroo Island, Australia. The long bird-like beak projects from behind the plant which conceals the animal's face.

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"Derby, W. A. (32 miles southeast): Twenty-three days were spent in the above locality, August 7-29. The locality visited was very poor in both mammal and bird life and a collection of only 43 mammals, 68 birds and 10 reptiles secured."

FIG. 55.—A native of North Australia.

In the last letter received from Mr. Hoy, from Port Darwin, Northern Territory, dated September 25, 1920, he writes, in part, as follows:

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"I have decided to work the Northern Territory and then go overland to Queensland via the old wagon road. I will travel in a buckboard and will go south from here, to the Catherine River, then east along the Roper, and then to the McArthur. On reaching the latter river I will go south along the river, then to Anthony's Lagoon and east across the tableland to some point in Queensland—most likely Gloncurry. The trip will take about four months and will have many advantages. The road is an easy one, being an old established route with plenty of good water along the way, and the trip ought to be productive of very good results."

During the year two shipments were received from Mr. Hoy, the last one arriving here in September. A total of 440 mammals, well prepared, several of which were hitherto unrepresented in our collection, together with series of skeletal and embryological material; 570 bird skins, with 24 additional examples in alcohol, and smaller collections of reptiles, amphibians, insects, marine specimens, etc., were received.

Up to the time of Mr. Hoy's visit to Australia the Museum had received not over 900 specimens of birds from that country; the majority of these were old, mounted, and without precise data, some of them dating back to the time of the Wilkes Exploring Expedition. About 350 mounted birds, displayed at the Centennial Exposition in Philadelphia in 1876, by the several Australian colonies, and presented to the National Museum at the close of the exposition, formed the largest single contribution to our collection; the remainder of the material consists of many smaller lots, obtained by gift or exchange at long intervals. About 140 species, including several of the distinct forms of Kangaroo Island, are represented in the material received from Mr. Hoy, all well prepared and with adequate data. Some of them are quite new to the Museum collection, and others, such as the lyre bird, have not previously been available in our study series.

BIOLOGICAL EXPLORATION IN HAITI

Dr. W. L. Abbott, of Philadelphia, accompanied by Mr. E. C. Leonard, of the National Museum, as botanical collector, made a visit of exploration to southern Haiti from February to July, 1920. Dr. Abbott undertook this visit chiefly that he might study the bird life of Gonave Island, hoping to complete certain series he had collected on a former visit. The island is about 30 miles long and 10 miles broad, and consists of a low mountain range bordered by a belt of foothills that merge gradually on the north coast to a level beach fringed by mangroves, but on the south slope descend rather abruptly into the sea. Dense thorn thickets cover the arid mountain sides and foothills, while the uplands, called La Table, open into

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large grassy tracts with only occasional trees or shrubs. Due to the scarcity of water and, in many places, to large outcrops of bare coral rock, the island is poorly adapted to agriculture, but the grassy uplands furnish excellent grazing. The forests yield a fair amount of lignum vitae. The party spent three weeks on the north coast, working around Anse Galette and Etroite, and later a week on the south coast in the vicinity of a small fishing village called Pikmi.

The regions visited on the mainland were St. Marc, Etang or Manneville, Fond Parisien, La Mission, Furcy, and Pétionville, with Port au Prince as base.

FIG. 56.—Royal Palm groves of Fond Parisien.

Etang is on the northwest shore of Etang Saumatre, a large lake nearly 20 miles east of Port au Prince, bordered on the west by the plains of the Cul de Sac, on the north by the mountains of Grand Bois, and on the south and east by the foothills of La Selle Mountains. The lake is about 50 feet below sea level and very salty. Among the interesting natural features of the region is a series of large springs, flowing into the lake through a belt of marshy meadows which are covered by a short sod composed almost entirely of several species of sedges. An excellent opportunity was offered to study both the arid cactus forests and cat-tail marshes that occur in the Cul de Sac.

The large royal palm groves of Fond Parisien, situated on the southeast shore of Etang Saumatre, give it a picturesque appearance.

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In old French times Fond Parisien was considered one of the most beautiful spots in Haiti, but a flood has covered the greater part of this once fertile district with stones and gravel, transforming it into a desert. The large areas of black mucky swamp land to be found

FIG. 57.—"Strangler plant" (a species of *Clusia*) on a large leguminous tree near Pétionville.

here are utilized in sweet potato farming, while some cotton is grown in the drier parts.

La Mission is a day's journey to the south from Fond Parisien. The most striking features of this region are the open pine forests

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FIG. 58.—Pic de Bromt (called "Morne de Wézan). A new species of grass was found growing on the summit of this mountain.

FIG. 59.—Weaver bird and nests in a thorn tree. Fond Parisien.

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and occasional wet thickets, the latter sheltering a luxuriant growth of ferns. The natives are, however, rapidly destroying the pine trees both by burning the forests repeatedly and by girdling the pines for splinters, which are sold in the markets as kindling.

Furcy and Pétionville are not far from Port au Prince. Both are easily accessible and are among the few localities which have been visited by naturalists.

Nearly 10,000 specimens of plants were collected, as well as a number of land shells and insects.

The birds obtained by Dr. Abbott during this expedition numbered 201 skins, with a few alcoholic specimens and skeletons. By far the most interesting ornithological observation made was the discovery in some abundance of an introduced weaver bird, *Hyphantornis cucullatus* (Müller), a native of West Africa. This species was found at several points in Haiti, where it occurs in colonies and affects much the same type of country as do related species in Africa. Nearly completed nests, without lining, were found about the middle of May, but no eggs had been deposited at this date. They are strongly woven of narrow strips of palm or banana leaves, and have an entrance at the side. An illustration of the manner of nesting is shown in figure 59. Two smaller species of west African weavers, belonging to other genera, are known to occur in Porto Rico, where they have existed for many years, but the date and circumstances of their introduction, as well as those of the species discovered in Haiti, are at present unknown.

MALACOLOGICAL FIELD-WORK IN CALIFORNIA AND THE HAWAIIAN ISLANDS

On the way to the First Pan-Pacific Scientific Congress held in Honolulu, August 2-20, 1920, Dr. Paul Bartsch, curator of mollusks, U. S. National Museum, stopped for three days in Glacier National Park, where some collections were made.

He also spent a day on shipworm investigation about Mare Island, where he had placed at his disposal, by the commandant of the station, a tug and pile extractor, and the necessary officers and men to make every minute of his stay count, the result being a careful examination of pilings throughout the stretch of San Pablo Bay and the adjacent shores of San Francisco Bay. This investigation resulted in establishing the fact that the mollusk which has been doing the damage estimated at some $25,000,000 last year is a new species of *Teredo,* which Dr. Bartsch has named *Teredo beachi* in honor of the commandant of Mare Island.

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Dr. Bartsch, in preparing a monograph on the land shells of the *Epiphragmophora californiensis* group, was very much puzzled how to account for the presence of two very closely related subspecies at Pt. Pinos, California. He took this occasion to visit Pt. Pinos, and there found that the two subspecies do not occupy the same habitat. The smaller of the two was found in great abundance under plants on two of the rocks lying off the Point, separated from the mainland by a gap across which one could easily leap, while the larger subspecies, which was rather rare, was found on the ground, buried beneath needles and vegetable detritus. Two subspecies of the

FIG. 60.—The home of *Epiphragmophora californiensis* Lea, a species of land shells, off Pt. Pinos, California.

Epiphragmophora tudiculata group were found to occupy a similar range.

Mr. Henderson and Dr. Bartsch arrived in Honolulu a few days prior to the meeting, and this time was used for collecting land, fresh-water, and marine shells on the island of Oahu. They also collected mullusks during their sojourn about the wonderful crater of Kilauea, on the occasion of the visit by the congress to the island of Hawaii. Several stations were likewise made between Kilauea and the Kohala coast. A large number of marine shells were secured from the rocky shores of Honaunau Bay.

Since the first accommodations to be secured for the return were dated September 8, the intervening time between the close of the

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congress and this date was spent in collecting specimens. Dredgings were made in Pearl Harbor, where the commandant placed one of the dredges at their command. They were also rendered the necessary assistance in making a search for shipworms, with the result that a new species of *Teredo* was discovered, which has been named *Teredo parksi,* in honor of Admiral Parks, in charge of Yards and Docks, U. S. N. They also dredged in Maunalua Bay, on the south side of Oahu and in Kaneohe Bay, on the east side of the same island. Specimens were also collected on various occasions at Haleiwa Beach, on the north end of Oahu, and the beach and shallow water adjacent to their cottage at Waikiki were thoroughly scratched over. Trips were also made into various parts of the mountains, where land shells of many kinds were secured.

Another excursion carried them to the island of Maui, where marine shells were collected wherever possible along the shore, and land shells were secured on their ascent of the magnificent extinct volcano of Haleakala.

One of the very interesting observations made on this trip to the Hawaiian Islands was the finding of an existing marine flora and fauna at a considerable elevation above the level of the sea on the gently sloping bench at the southeast point of Hanouma Bay. This flora and fauna consist of algae, quite a number of species of mollusks, crustaceans, echinoderms and other marine organisms, which occupy pools and puddles kept ever moist and supplied with fresh water by the spray from the breaking surf, which incessantly pounds that shore. Dr. Bartsch considers this an important observation, since the occurrence of fossiliferous laminae bearing marine organisms between sheets of lava has been held to indicate that they were deposited at or below sea level and their occurrence above this has been held as evidence of elevation. We have here an instance which indicates that this is not necessarily the case, for such a lamina would be produced if a new outpouring of lava were to cover up the place mentioned.

BOTANICAL EXPLORATION IN JAMAICA

In February, 1920, Mr. William R. Maxon, Associate Curator in the Division of Plants, United States National Museum, and Mr. Ellsworth P. Killip, aid, were detailed to make botanical collections in Jamaica. The expedition was made possible largely through the co-operation of the New York Botanical Garden, the Gray Herbarium of Harvard University, the Field Museum of Natural History, the University of Illinois, the Arnold Arboretum,

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FIG. 61.—Windsor Plantation, south of Port Antonio.

FIG. 62.—Residence at Cinchona.

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FIG. 63.—Higher peaks of the Blue Mountains as seen from the southwest; Mossman's Peak (unexplored) at the left, separated from Blue Mountain Peak (2,225 meters) by Portland Gap.

FIG. 64.—In the heart of the Blue Mountains. The denuded areas are landslips due to erosion in areas long under cultivation in coffee.

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and Mr. Oakes Ames in contributing to the field expenses of the work. Two months were spent in the island, and upwards of 10,000 specimens were brought back, representing about 1,700 collection

FIG. 65.—Fern-covered bank on trail to Morce's Gap. The tree ferns in the center are *Cyathea pubescens.*

numbers. The material has been shared among the contributing institutions, the ferns and flowering plants having already been fully identified.

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From headquarters in Kingston field-work was carried on in several widely separated parts of the island, the courtesy of free transportation on the Jamaica Railway having been extended by the colonial government. Through the kindness of Mr. J. G. Kieffer, general manager of the United Fruit Company in Jamaica, a house on the company's plantation at Windsor, in the rich banana region south of Port Antonio, was placed at the disposal of the party. About 10 days was spent here, trips being made to Mooretown, Mill Bank, Cuna Cuna Pass, and the northern foothills of the John Crow range.

FIG. 66.—A characteristic fern (*Dicranopteris bifida*), growing in vinelike masses near Morce's Gap.

The most productive period was one of three weeks in March, spent in the Blue Mountain region, with headquarters at the botanical station at Cinchona, the lease of which had been renewed by the Smithsonian Institution in January, 1920. Located on a projecting southern spur at an altitude of 1,500 meters, equipped with a serviceable laboratory and most comfortable living quarters, Cinchona served as an excellent base for botanical exploration in the Blue Mountain region, most of the peaks lying within fairly easy reach. Extensive collections were made on John Crow Peak, at New Haven Gap and Morces Gap, and in the vicinity of Cinchona, as well as on trips to Thompson's Gap, Hardward Gap, and the summit of Blue Mountain

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Peak. Over 800 numbers were collected in this region. In preparation for a projected work by Mr. Maxon on the ferns of Jamaica, particular attention was paid to this group, nearly 200 species being here collected.

Other regions visited include Hollymount, on the upper slopes of Mount Diabolo, in the central part of the island, the coastal territory of Montego Bay, and the southern border of the "Cockpit Country," the last a wild, little inhabited, wooded area of innumerable limestone sinks lying southeast of Montego Bay. Collections at Cook's Bottom, Mulgrove, Mocho, and Ipswich yielded a number of new or otherwise very interesting species. Just before leaving Jamaica Mr. Maxon made a brief visit to Pigeon and Great Goat islands, lying off Old Harbour.

Much of the success of the trip is due to assistance extended freely by officials of the United Fruit Company, acknowledgment of which is gratefully rendered.

BOTANICAL EXPLORATION IN BRITISH GUIANA

Mr. A. S. Hitchcock, Custodian of Grasses, visited British Guiana, making the trip through the co-operation of the United States Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium. He left New York, October 4, 1919, and arrived at Georgetown, October 22, stopping on the way at St. Thomas, St. Croix, St. Kitts, Antigua, Guadeloupe, Dominica, Martinique, St. Lucia, and Barbados. He left Georgetown, February 2, 1920, and arrived in New York, February 16, stopping four days in Trinidad and one day at Grenada.

Six weeks were spent at Georgetown, and other points along the coast; three weeks at the Penal Settlement on the Mazaruni River, from which were visited Bartica, Kalacoon, and Kartabo; two weeks on a trip up the Demerara, Essequibo, and Potaro rivers to Wismar, Rockstone, and Tumatumari; and ten days on a visit to the Northwestern Distict, including Morawhanna on the Barima River, Issorora, the Rubber Station on the Aruka River, and the Yarikita Police Station on the Venezuelan border.

Four sets of plants were collected including 1,134 numbers, with extra sets of the grasses. On account of the extremely damp climate it was necessary to use artificial heat in drying the specimens. Two oil stoves were kept burning night and day, the specimens being between corrugated paper. After drying, the plants were sprinkled with naphthalene powder to prevent subsequent molding.

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British Guiana has an area of about 90,000 square miles, is about 400 miles deep, and extends about 250 miles along the coast (Lat. 1°-8° N., Long. 57°-61° W.). There are three counties: Demerara, including the drainage system of the Demerara River and to the Abary River on the east; Essequibo, including the drainage system of the Essequibo River and all to the west; and Berbice, including

FIG. 67.—St. Thomas. The wall is covered with coralita (*Antigonon leptopus*), an ornamental vine with handsome racemes of pink flowers. The palms are royal palms.

the drainage system of the Berbice River and east to the Courantyne River. Georgetown, at the mouth of the Demerara River, has a population of about 60,000. The only other city is New Amsterdam, at the mouth of the Berbice River, with a population of about 9,000. The entire population of the colony is about 300,000, about 4,000 of whom are whites. The bulk of the population consists of East

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Indians (42.7 per cent) and negroes (39 per cent). The chief product of the colony is sugar, which, together with the by-products rum and molasses, constitutes about three-fourths of the exports. Other products are gold, rice, balata, timber, and cattle. The country is fairly healthy, the death rate being about 35 per 1,000 (14.8 per 1,000 among whites). Yellow fever is absent, but malaria and dysentery are prevalent.

FIG. 68.—Antigua. An old sugar mill. These old stone mills, formerly used for crushing the cane, are common on the islands. Oxen were attached to the long beam. The crushing or grinding is now done in modern sugar factories.

The rainfall at Georgetown is about 90 inches, with a dry season September to November, and another short dry season in the spring. The temperature at the same place is, in the daytime, about 88° F. in the summer, falling four to six degrees at night, and in winter four to six degrees lower. The temperature at night in winter rarely falls below 75° (the minimum record for 35 years is 69°).

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The coastal region of the colony for 10 to 40 miles inland is a flat plain scarcely above sea level. Back of this there is a belt with hills

FIG. 69.—Georgetown, British Guiana. One of the main streets with rows of rain tree (*Samanea saman*).

FIG. 70.—Morawhanna, British Guiana. A typical village of the interior.

as much as 200 feet high. Toward the southwest the land rises and at the Venezuelan-Brazilian border culminates in the famous Mt. Roraima, a table mountain rising to a height of 8,500 feet. With

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the exception of the savannas of the southern part of the country (Rupununi District) and a few other small areas, the whole country is covered with dense virgin rain-forest.

Communication in the interior is almost entirely by boat along the numerous streams, but unfortunately is hindered by falls and rapids above the influence of the tide (30 to 60 miles).

FIG. 71.—A giant mora tree (*Dimorphandra excelsa*) in the virgin forest of British Guiana, near Tumatumari. The base is broad and buttressed. Attached to the trunk is a species of Marcgravia.

The scientific activities of the colony are mainly under the control of Prof. J. B. Harrison, Director of Science and Agriculture, who extended to Mr. Hitchcock many courtesies.

The Jenman Herbarium, an important collection of British Guiana plants, is at the office of the director in Georgetown. There is an excellent botanical garden with a large collection of trees and shrubs, including a very fine series of palms.

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COLLECTIONS OF LIVING ANIMALS FOR THE NATIONAL ZOOLOGICAL PARK

As in former years, friends of the Smithsonian Institution, while on expeditions abroad, collected and sent to Washington interesting living animals for the National Zoological Park.

Mr. W. J. La Varre, who has before made collections of this kind, visited South America and explored the upper waters of the Amazon.

FIG. 72.—Animals for the National Zoological Park awaiting shipment at Manaos, Brazil. Photograph by La Varre.

He left the United States in June, 1919, and traveled directly to Manaos, Brazil, the jungle metropolis about 1,000 miles up the Amazon at the mouth of the Rio Negro. From Manaos he ascended the Rio Negro, by small steamer and launch, into Venezuela. He found much of interest, but no trace of the so-called "cannibals" of the region, or of anything savage, either beast or man. The natives, poor, half-breed rubber gatherers—Spanish, Portuguese, Negro, and Indian mixtures—treated him cordially and most hospitably, sharing their rude homes of thatch with him and giving him as much of their food as they could possibly spare. Six months were spent with these

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FIG. 73.—Girls of the Rio Negro, Brazil. Photograph by La Varre.

FIG. 74.—Native Batalao of rubber gatherers, Rio Negro, Brazil. Photograph by La Varre.

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kindly, primitive people, in geographical and zoological research, exploration, and hunting.

The general scarcity of mammal life along these famous rivers was surprising. So many rubber gatherers live here that the country has,

FIG. 75.—Border marker between Brazil and Venezuela, with government officials of both countries. Photograph by La Varre.

in fact, been hunted out, and the natives themselves are often hard pressed for food. Pacas and peccaries were plentiful, and numbers were shot for use in the camp. Tapir tracks were crossed several times, and small deer were occasionally killed by the natives.

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Curiously enough, only two wild monkeys were observed, although examples of various species were commonly seen in the possession of natives. Birds, on the contrary, were plentiful—among the conspicuous species were toucans, curassows, macaws, and parrots. Mr. La Varre left the jungle in February, and arrived in the United States near the end of March, 1920. His collection of living animals, which he presented to the park, included a specimen of the rare black-headed ouakari monkey (*Cacajo melanocephalus*), a species never before represented in the collection. This monkey is a member of the

FIG. 76.—White-backed Trumpeter (*Psophia leucoptera*) from the Rio Negro, now in the National Zoological Park. Photograph by La Varre.

only genus of short-tailed monkeys inhabiting the New World, and is very seldom seen in captivity.

Other animals in the La Varre collection are capuchin and squirrel monkeys, an ocelot, two margay cats, egrets, a scarlet ibis, and a number of parrots and paroquets. A large living specimen of the rare and curious matamata turtle, a gift to the park from Mr. A. T. S. Hore, of Manaos, was brought home with the lot. Another American resident of Manaos, Mr. Edward B. Kirk, also contributed some interesting birds, among which was a fine specimen of the very rare white-backed trumpeter (*Psophia leucoptera*) from the Rio Negro.

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A second collection of living Neotropical animals was brought to the park by Dr. William M. Mann, of the Bureau of Entomology, United States Department of Agriculture, who visited Honduras in the spring of 1920. Dr. Mann's duties in other lines naturally absorbed most of his time, but he succeeded in landing in good condition a number of valuable animals. His collection included pacas, agoutis, kinkajous, squirrels, a mantled howler monkey, and some reptiles, among which was a specimen of Rossignon's snapping turtle, a species rarely taken by collectors.

Other valuable animals were collected and presented to the park by Hon. Henry D. Baker, American Consul at Trinidad, British West Indies, and by Mr. Isaac Ellison, of Singapore, Straits Settlements. Mr. Ellison succeeded in landing and placing in the park a thrifty young male orang-utan, three years old. This is one of the most interesting and valuable gifts received in many years. The animal has now become thoroughly adapted to his new home and promises to become a most unusually attractive addition to the collection.

The National Zoological Park also shared in the large collection of African animals collected and brought to America for the New York Zoological Society by Mr. A. K. Haagner, director of the National Zoological Gardens at Pretoria, South Africa. Included in the lot received at Washington are a lechwe antelope and a specimen of the Rhodesian baboon, recently discovered and described by Mr. Haagner.

ANTHROPOLOGICAL EXPEDITION TO THE FAR EAST

Under the auspices of the Smithsonian Institution and in connection with the Rockefeller Foundation and the Peking Union Medical College, Dr. Aleš Hrdlička made an extensive trip to the Far East during the first half of 1920. The objects of this trip were continuation of the studies relating to the origin of the American aborigines; examination of the oldest skeletal and other human remains in Japan; the furthering of the interests of physical and medical anthropology in China; and a personal visit to the rapidly disappearing full-blooded Hawaiians. The countries visited included Japan, Korea, Manchuria, northern China, the boundary of southern Mongolia, and the islands of Oahu and Hawaii in the Hawaiian Archipelago.

In Japan especial attention was given on one hand to the physical characteristics of the people, and on the other to the prehistoric anthropological collections. The latter have by now assumed considerable importance. They are deposited in the universities and medical schools of Tokio, Kyoto, Sendai, Osaka, and Kumamoto,

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FIG. 77.—Average types of Japanese children. Photographs presented by Mr. Tsunawo Araki.

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and are being steadily added to by new explorations in prehistoric mounds and shell heaps. They date all from the Neolithic period, nothing earlier having thus far been discovered in eastern Asia; and they show both an old diversity, as well as more or less relation to the Aino and to the Japanese.

FIG. 78.—Japanese child.

In Korea special facilities were obtained for visiting the museum at Seoul, which was found unexpectedly rich in Korean and Turkestan antiquities. The people represent quite a distinct subtype of the yellow-brown stem from that of the Japanese as well as that of the Chinese; they are more like the western Siberian or southeastern Russian Tatars.

One of the most interesting features in Korea are the mound burials of the people. These mounds are all hemispherical, in contradistinc-

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FIG. 79.—Of the best in Central Japan. Photographs presented by Mr. Tsunawo Araki.

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tion to the conical mounds of Manchuria and northern China. They are of various sizes; they occur singly, in clusters, and in whole "cemeteries": they are frequently assiduously cared for, and many are most picturesquely located on the slopes of hills, where they appear to the best advantage. The Koreans are a modern race of mound builders. The country is full of archeological remains, including some big mounds and dolmens, and deserves much closer scientific attention than it has so far received.

FIG. 80.—A Korean Hamlet. From a few houses to large villages, they cluster in the nooks of the hills like mushrooms.

The Manchus and the northern Chinese, particularly those of the Chihli Province, are for the most part tall, well-built people, quite different in bearing and even in physiognomy from the southern Chinese, though there is no sharp delimitation. They, too, present a fruitful field for detailed anthropological investigation.

The southern or inner Mongolians were found to be a rather mixed lot, more so than the northern Mongolians who were visited by Dr. Hrdlička in 1912. A series of photographs was secured here as well as in Korea and Japan. In Japan, through the kind help of Dr. Tsunawo Araki, there was obtained a large collection of portraits

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of Japanese children, while the Tokyo Dental College, through the good offices of Professor Mitsuru Okada, contributed several hundreds of portraits of its students.

China, for the anthropologist and archeologist, is one vast open museum, in which something of absorbing interest is met with at almost every step. In addition the people, and particularly the students in colleges, impress one with their native abilities. China in the future may well be relied upon to give the world many a philosopher and scholar of distinction.

FIG. 81.—Mounds near a Korean village. At sunrise on special days it is not unusual to find before each mound a prostrate figure in devotion before the grave of a father or mother.

The stay at Peking was principally devoted to assisting in the development of the medico-anthropological work at the Union Medical College, and the organization of the "Anatomical and Anthropological Association of China." The college has an excellent staff of well-trained young workers such as Drs. Cowdry, Black, Howard, and others, the majority of whom are seriously interested in those branches of anthropology which are nearest the medical sciences; and there are bright prospects for anthropological work in other parts of China, due to the presence there of English-speaking (mostly American)

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FIG. 82.—Babies and their nurses at Sen Sen, Korea.

FIG. 83.—A young matron of a good family, with baby and servant, at Sen Sen, Korea.

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medical missionaries, who are naturally interested in investigations of that nature.

While at Peking, certain investigations were carried on, with the help of Professor Davidson Black, on Chinese teeth; and a conference was held with the representatives of several Chinese ministries, as well as of the Chinese Geological Survey and the Peking Union

FIG. 84.—A Korean girl.

Medical College, on the subject of the foundation at Peking of a "Museum of Natural History of China," the establishment of which would mean so much for the progress of the Chinese themselves, and for facilitating the work of foreign men of science in the Chinese Republic. There exists already, under the direction of Dr. V. K. Ting, a very creditable geological museum, which could serve as a nucleus of the more comprehensive institution.

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FIG. 85.—The surgical class at Severance College, Seoul, Korea, Dr. A. I. Ludlow operating.

FIG. 86.—Chunhuzes. A rare photograph of the North-Mongolian brigands.

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On the return trip a stop was made at Hawaii, and with the kind assistance of the staff of the Bernice Pauahi Bishop Museum at Honolulu, and particularly of Dr. Gregory and Mr. Stokes, some studies were carried out on the native Hawaiians in several of the most favorable localities. It was found that the Hawaiians, even

FIG. 87.—Chinese woman with artificially deformed feet, at Peking. This crippling deformation is still extensively practised by the Chinese. A Chinese woman without deformed feet is not regarded as "comme il faut."

where free from historic admixture with whites or negroes, present an old blend of several ethnic elements (yellow-brown, Indo-European, and Negro or Negrito); this blend, however, has already reached a degree of approach to physical unity which permits the student to deal with it as with a racial subvariety or subtype. But this subtype is rapidly vanishing through new contacts.

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FIG. 88.—Full-blood Hawaiian.

FIG. 89.—Full-blood Hawaiian.

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FIG. 90.—Full-blood Hawaiian.

FIG. 91.—Full-blood Hawaiian.

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THE OJIBWA OF MINNESOTA

During the fall of the past year, Dr. Aleš Hrdlička was called once more to Minnesota to assist the Department of Justice in settling the subject of mixed bloods and pure bloods among the Ojibwa. (See Smithsonian Explorations for 1917.)

The whole work, now concluded, presents a good illustration of the practical value of anthropology in certain directions. The results are outlined in the following extracts from a letter to the Institution from Mr. R. C. Bell, Special Assistant to the Attorney General:

The Department of Justice in 1910 instituted approximately 1500 suits in the United States Court for the District of Minnesota involving Indian lands. This litigation to January, 1916, has cost the government a very large sum and little had been accomplished.

The blood status of the Indians became the determining factor and it was ascertained that all the available evidence (principally testimony as to genealogy) on this issue was found unreliable and always unsatisfactory. Consequently, the Department of Justice, in the spring of 1916, procured the services of Dr. Hrdlička to make a physical examination of the Indians and report his conclusions as to their status. The doctor spent more than three months in this work and examined approximately 800 individuals.

The Department of Justice, the Department of the Interior, and counsel for the defendants agreed to accept his findings as a basis for settlement, and the litigation now has been terminated, resulting in the recovery of more than $1,000,000 in land and money for the Indians; besides, the cost of the work since 1916 has been insignificant in comparison to the cost prior to that time.

Furthermore, a commission was created by an Act of Congress to make a roll of the allottees of the White Earth Reservation. The law required, in addition to much other information, that the blood status of the Indians be given. This roll, which affects the title to approximately 725,0000 acres of land, has been completed; and the commission in preparing it followed the findings of the doctor. Only those thoroughly familiar with the situation can appreciate the far-reaching importance of this work.

FIELD-WORK ON THE MESA VERDE NATIONAL PARK

The Chief of the Bureau of American Ethnology, Dr. J. Walter Fewkes, continued his field-work on the Mesa Verde National Park, Colorado, during June, August, and September, 1920, in cooperation with the National Park Service of the Department of the Interior. Excavation and repair work was done on the Fire Temple Group and Oak Tree House, ruins in Fewkes Canyon and at Cedar Tree Tower, situated about a mile north of Spruce Tree House, leading to important contributions to our knowledge of the culture of cliff dwellers.

He was ably assisted in this work by Mr. J. A. Jeancon, who made the originals of the ground plans of the Fire Temple Group and Cedar Tree Tower here published.

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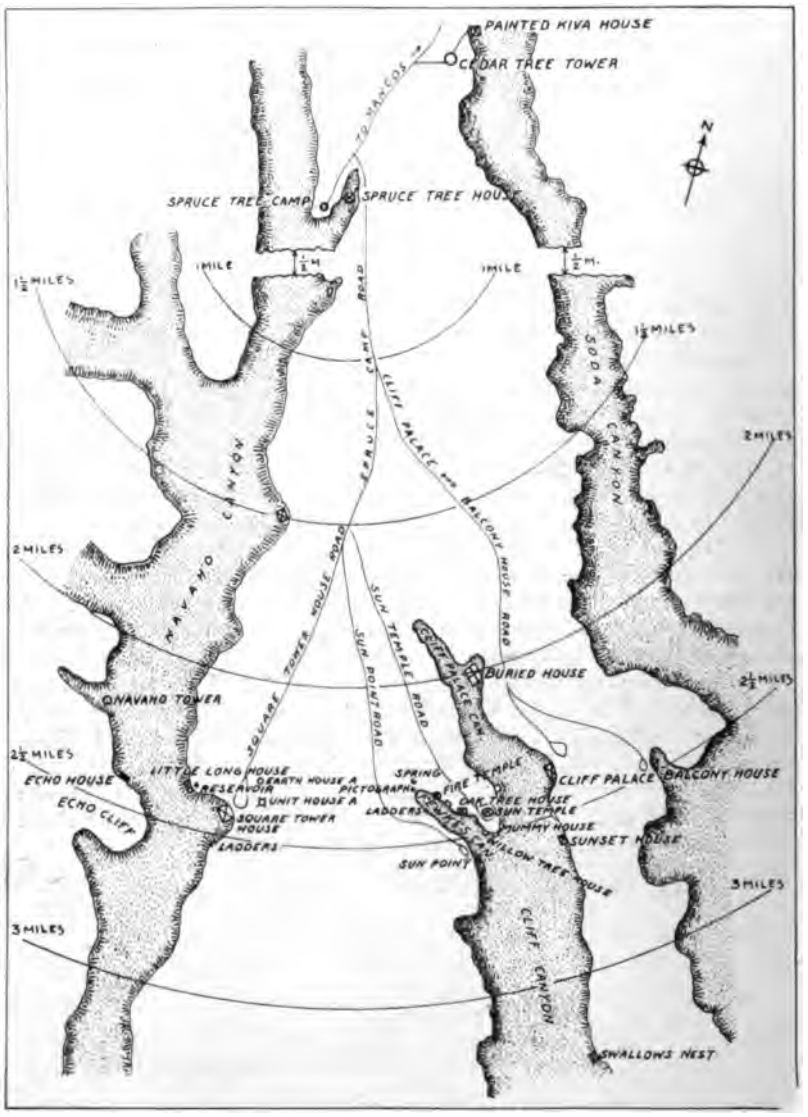

FIG. 92.—Map of Sun Temple Area in the Mesa Verde National Park, Colorado.

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The opening of Sun Point Road along the south rim of Fewkes Canyon (fig. 92) is a most important addition to the park from the tourist's point of view. For about a quarter of a mile along this road one can look down into Fire Temple (fig. 94) and Fire Temple House, Oak Tree House (fig. 103), and the two ruins under Sun Temple, the walls of one of which, Willow Tree House, are in the same condition as when the cliff dwellers left the mesa; the other,

FIG. 93.—Ladders into Fewkes Canyon from Sun Point Road, opposite Fire Temple. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

Mummy House, on a lower level, is notable for its fine masonry. On the point across Fewkes Canyon, rise in full view the walls of Sun Temple, and beyond it, nestling in the cliff, is the magnificent Cliff Palace. The fine cliff dwelling Sunset House ("Community House"), a prominent ruin in Cliff Canyon, is likewise conspicuous. The road along Fewkes Canyon from which these prehistoric buildings are visible has already become a very popular drive, being only about two and a half miles from Spruce Tree Camp. The accom-

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panying map (fig. 92) shows the relative position and approaches to the above mentioned ruins. A fine trail, one of the most beautiful in this area, was developed under the north rim of Fewkes Canyon, to

FIG. 94.—Fire Temple from Sun Point Road. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

connect the above ruins. Three ladders (fig. 93) placed in the cliff opposite Fire Temple enable the traveler to reach this trail, which ends in ladders on the canyon rim opposite Cliff Palace near the point

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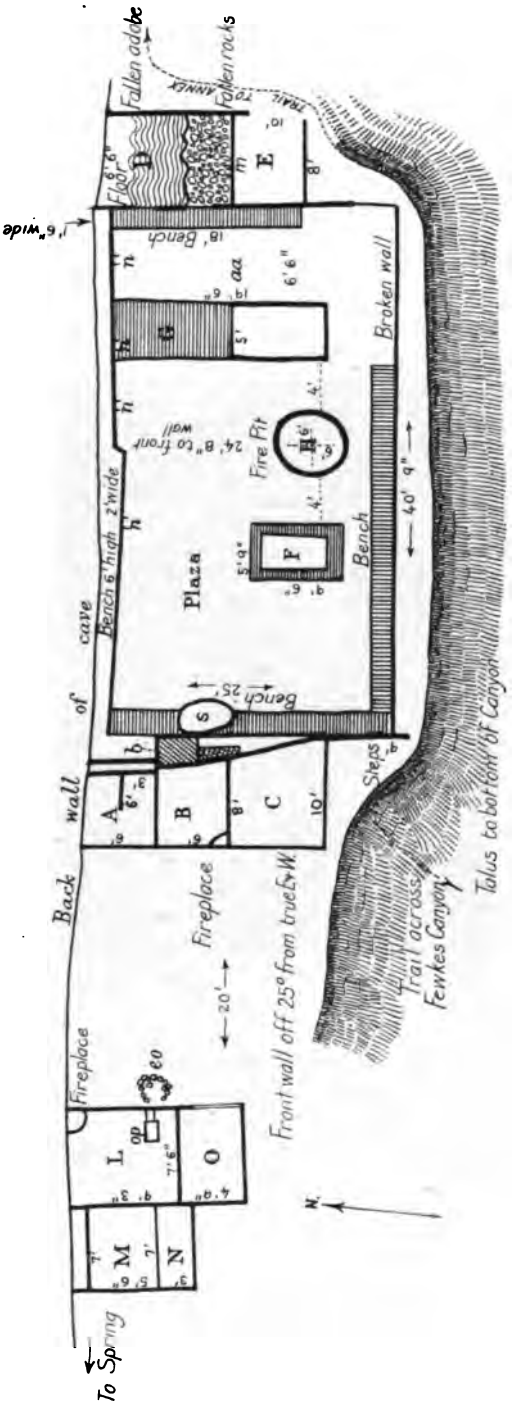

FIG. 95.—Ground plan of Fire Temple.

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where the discoverers stood when their eyes first beheld this most impressive cliff dwelling of the Southwest.

The most important discovery of the past season was the determination by excavation that a large cliff house was not a dwelling, but specialized for some communal purpose. This ruin (fig. 98) was devoted to fire worship, a cult which up to this year, although suspected, had not been demonstrated as existing among cliff dwellers—at least no specialized building for that function had been recognized.

In 1915 there was discovered on the promontory opposite Cliff Palace a building with semicircular ground plan that was interpreted

FIG. 96.—Western end of Fire Temple Court, half excavated. Photograph by Fewkes.

as a specialized religious structure and called Sun Temple. While work on it was in progress a reconnoissance was made of cliff houses situated in the canyon below, to one of which was given the name Painted House. Like Sun Temple, it was suspected of having also been dedicated to some religious cult of the cliff dwellers, but its true significance was not apparent until the spade of the archeologist last season verified this suspicion and revealed its true purpose. Painted House, upon excavation, proved to be one of the most exceptional cliff ruins yet recognized in the Southwest. The results of the excavation have led Dr. Fewkes to designate it Fire Temple, and by

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implication to regard it a temple of the eternal fire. Attention should be called to the importance of the discovery that the cliff dwellers had a New Fire Cult and possibly that rites of new fire and conservation of the same existed among prehistoric people of the Mesa Verde.

The rites of kindling the new fire among the descendants of the cliff dwellers, as the Hopi, occur in July and November and are known as the Lesser and Greater fire ceremonials. The act in both is performed by means of a fire stick or drill made to rotate in a

FIG. 97.—Eastern end of Fire Temple Court. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

notched board; the same kind of fire sticks have been found in Spruce Tree House, Square Tower House, and elsewhere.

Probably it is to the Lesser Fire ceremony at the East Mesa of the Hopi that we should look for the nearest survival of the cliff dweller's rite, as in it we find the personation of a phallic being, Kokopelli, whose picture was well preserved up to a few years ago on the wall of the secret chamber of the Fire Temple where fire was created. This Lesser New Fire, called Sumykoli, is celebrated by a fraternity of fire priests, now extinct, known as the Yaya priesthood. The Yaya priest at Hopi carries in his hand during this ceremony a rattle of

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FIG. 98.—Fire Temple Group of Ruins. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

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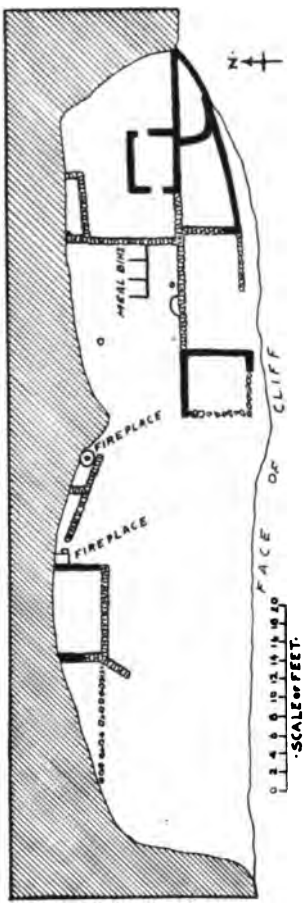

FIG. 99.—Ground plan of Upper Cave of Fire Temple House.

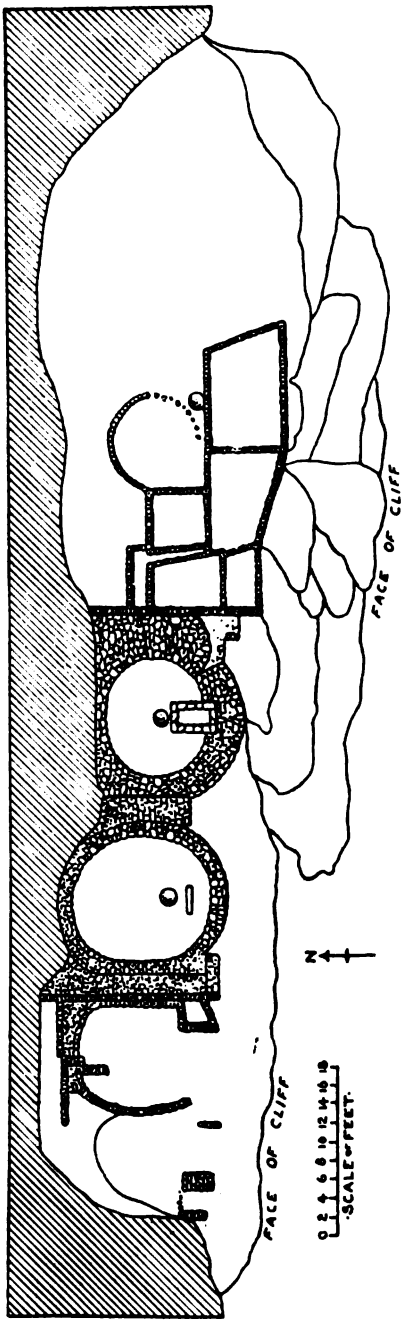

FIG. 100.—Ground plan of Lower Cave of Fire Temple House.

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exceptional construction. Two of these, now in the museum of the Brooklyn Institute, were found in a cliff dwelling in the Chelly Canyon, which seems to indicate that there formerly existed among the cliff dwellers of that canyon a fire priesthood like the Hopi Yaya. As the cliff dwellers of Chelly Canyon and those of the Mesa Verde were closely related it is a fair conclusion that the latter also had a well-developed New Fire Cult, and possibly a Yaya priesthood.

The masonry of Fire Temple points to an early epoch in the evolution of the Mesa Verde culture, possibly one contemporary with the

FIG. 101.—Western end of Fire Temple Court. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

first settlement in Cliff Palace cave, but anterior to the erection of the unfinished Sun Temple, which marks a later or culminating phase of cliff house development. Architectural features that Fire Temple shares with Sun Temple may be interpreted by the close relationship of fire and sun cults among the cliff dwellers. Earth Lodge A, excavated in 1919, is the ancient type in the evolution of buildings on the mesa antedating stone walls, and there are evidences of successive stages illustrating cultural epochs from the crude Earth Lodge A, which the earliest colonists constructed, to those of horizontal ma-

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sonry (fig. 108), the highest products of the mason's craft in prehistoric North America. This evolution may have occurred on the area now reserved as a national park, but was not limited to it.

After the abandonment of Fire Temple and the desertion of buildings of the culminating epoch that followed, people of like culture may have still inhabited the great pueblos at Aztec and in the Chaco. But these in time also succumbed and were deserted before the arrival of the white man. Their descendants were amalgamated with nomadic or non-pueblo peoples and their survivors still inhabit the modern

FIG. 102.—Bins for grinding corn in upper cave of Fire Temple House. Photograph by J. A. Jeancon.

pueblos along the Rio Grande. Both blood and culture suffered changes in this mixture, and architectural features remain to especially indicate the modifications. The Hopi, Zuñi, and modern Rio Grande pueblos have no specialized buildings like Sun Temple nor Fire Temple for sun or fire cults, although they have ceremonial rooms where they formerly kindled the new fire annually. They no longer conserve the fire in this room, but there are legends that they did so in former times, pointing to a remote cultural connection between the cliff dwellers and their modern survivors, the Pueblos.

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The general form and arrangement of rooms at the east and west ends of the central court of Fire Temple differ from any cliff ruin or pueblo in the Southwest. Significant facts show that the building (fig. 97) is unique, as will readily appear from the following statements. Excavations in other cliff houses of the same size reveal household utensils, as pottery, and other domiciliary objects. No cooking places, grinding bins, or household implements were found in the extensive work at Fire Temple. Moreover, every cliff house of size on the Mesa Verde has one or more specialized gener-

FIG. 103.—Oak Tree House from Sun Point Road. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

ally circular subterranean rooms for ceremonies. There were no kivas in Fire Temple. But the one exceptional positive feature in this ruin that separates it widely from the cliff dwelling is stronger than these negative evidences. In no cliff house, and indeed in no pueblo, do we find a similar large circular fire pit filled with ashes in the center of a rectangular court. This structure would seem to be the key to the meaning of the whole building. That great fires were once built in this fireplace, as the abundant ashes indicate, no one can doubt. This fireplace is too large for an oven for culinary purposes and although we know that the cliff people sometimes cremated the dead the absence of calcined human bones would disprove the theory that

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it was used as a crematory. A natural conclusion would be that it was constructed for ceremonies connected with fire.

The significance of the two low-walled rectangular enclosures one on each side of the central fire pit, is unknown. Each was partially filled with soil and ashes when excavated and it is suggestive to record that the stratum of earth above them as well as the whole surface of the hardened floor of the court was filled or covered with charcoal and burnt brush. Great fires must have raged over the

FIG. 104.—Cedar Tree Tower before excavation. Photograph by J. A. Jeancon.

whole court in addition to that in the fireplace, after the temple was deserted.

We find several other facts that fit in very well with the interpretation that this building was a fire temple. On the east and west ends of the court (figs. 97, 101) there are banquettes, the former evidently seats for those who watched the ceremonial performance in the court. There are niches in the rear wall where possibly sacred objects may have been placed; a wall of the cliff bears triangles and zig-zag paintings, symbols of sex life; but, most important of all, on the wall of one of the rooms at the west end of the court there are paintings in red,

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one of which, now erased, represented a phallic being still associated with New Fire ceremonies among the Hopi, while others represent fire itself. At the New Fire ceremony among the Hopi one of the four fraternities that celebrate it is the order of Horn Priests, who wear on their heads imitations of the horns of mountain sheep. A large number of paintings of mountain sheep cover the walls of the west room of Fire Temple where fire was supposed to be kindled.

The massive walled buildings at the east and west (fig. 94) ends of the court formerly reached to the roof of the cave, and although two stories high no wooden beams for flooring occur in their con-

FIG. 105.—Cedar Tree Tower after excavation. Photograph by J. A. Jeancon.

struction. Wherever a lower story existed it was filled in with rubble on top of which was laid an adobe floor. On the white plastering, which is well preserved, there are numerous figures in red, mostly triangles and symbols of lightning; female and male symbols similar to those in sacred rooms.

Just west of Fire Temple there is a group of rooms from which utensils were excavated. In the floor of one of these rooms is a vertical shaft which opens outside the house walls like a ventilator. The former use of this structure is unknown.

Although Fire Temple was not inhabited there were undoubted dwellings nearby. A hundred feet east of it there are two low caves, one above the other, in which may have lived those who once made

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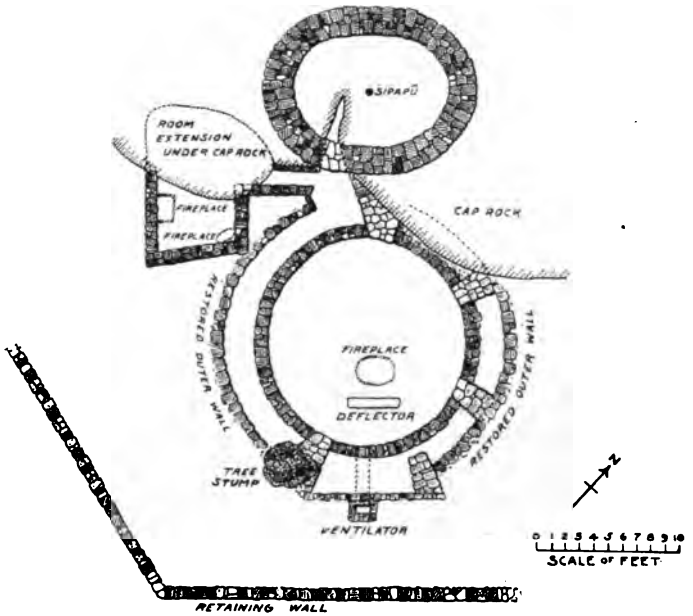

FIG. 106.—Below, Cedar Tree Tower and kiva; above, ground plan of Cedar Tree Tower and kiva. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

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use of this sanctuary. Dr. Fewkes has called the ruin (fig. 98) situated in these caves the Fire Temple House and supposes it was the habitation of the fire priests and their families. The rooms in the lower cave were fitted for habitation, and it had two, possibly three, circular ceremonial rooms; but the upper cave (fig. 99) is destitute of kivas. The large rooms of the upper house (fig. 100a) may have been granaries for storage of provisions, although possibly some of its rooms were inhabited. In the rear of the large rooms identified as granaries was found a small room with a well-preserved human skeleton accompanied with mortuary pottery. One of these mortuary offerings is a fine mug made of black and white ware beautifully decorated; a specimen worthy of exhibition with the best in any museum. In the rear of the cave were three fine grinding bins (fig. 102), with metates still in place.

The upper house is now approached from the lower by foot-holes in the cliff and a ladder shown in the illustration. Evidences of a secondary occupation of kivas in the lower house appear in double walls and those of crude masonry without mortar, forming a rectangular room built diagonally across the room. The plastering on the rear walls of the lower house is particularly well preserved, but there are very few rooms in addition to the kivas. One of the kivas has in place of a deflector and ventilator shaft a small rectangular trench enclosed by a well-made wall, as in Sun Temple.

Work was done on the large cliff ruin, Oak Tree House (fig. 103), on the trail an eighth of a mile east of Fire Temple Group. Three new kivas were excavated to their floors and the walls repaired, adding to the four already known. No signs of these buried kivas were visible when work began. All these kivas show fine masonry; after the most easterly had been used as a sanctuary for a time it was abandoned and five well-preserved grinding bins were set in the floor so as almost to conceal it. The upright slabs of stone and metates of these structures were reset, showing fine examples of these prehistoric mills. Many other novel features were brought to light in the excavation of Oak Tree House, which may be regarded as one of the most instructive ruins of the park. One of the exceptional features of Oak Tree House is a fragment of a circular wall in the rear of the cave, made of willow and other sticks set in mortar, like what is called "stick and adobe" construction in other regions.

The ground plan of one of the kivas is semicircular and shows a rectangular room on the straight side communicating with the chamber by means of two passageways. The ventilator opens directly into this room, whose function is unknown.

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In one of the grinding bins there was excavated a bundle of grass, *Koeleria cristata,* of exactly the same form as the brushes with which Hopi maidens sweep their metates after grinding meal; one more resemblance between cliff dweller and Hopi customs.

In his classic on the " Cliff Dwellers of the Mesa Verde," Baron G. Nordenskiöld figured and described a nameless ruin designated a tower (fig. 104), situated in the cedars about a mile north of Spruce Tree House. To this ruin the author has given the name Cedar Tree

FIG. 107.—Section of floor of Cedar Tree Tower, showing ceremonial opening. Photograph by J. A. Jeancon.

Tower, on account of an ancient cedar tree (fig. 105) hanging over the top of the north wall. Nordenskiöld closes his brief description with the remark, " Perhaps it should be regarded a religious building."

The desirability of testing this surmise of the talented Swede led the author, in August, 1920, to excavate this tower and the area about its base, which led to the discovery that although it appeared to stand alone there were two subterranean rooms connected with its base situated on the west and south sides. The larger of these rooms (fig. 106) had all the structural features of a typical kiva of a Mesa Verde cliff dwelling. This subterranean structure, its floor excavated

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in solid rock, was circular with pedestals for supports of a roof, the beams of which were absent, and had a central fire hole, ventilator, and deflector. It communicated with the tower by a subterranean

FIG. 108.—Square Tower House. Photograph by G. L. Beam. Courtesy of the Denver and Rio Grande Railroad.

passage which bifurcated, one branch opening through the tower floor, the other into a square room situated on the southwest side, also subterranean, partially constructed under a large rock forming a

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FIG. 109.—Yucca House National Monument, Lower House; Mesa Verde in the distance. Photograph by W. H. Jackson. Courtesy of the U. S. Geological Survey.

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veritable cliff chamber. In the middle of the solid rock floor of the tower which served as the foundation of the tower walls a circular hole or *sipapû* (fig. 107), symbolic of the entrance to the underworld, had been drilled, affording evidence that the tower was used for ceremonials. A distant view down Soda Canyon may be had from the top of the tower, although it is situated some distance from the rim of the mesa and shut in by a dense growth of cedars and pinyons.

An automobile road constructed around Cedar Tree Tower was continued through the cedars to join the Mancos road. Several ladders were placed in position and a trail opened down the steep wall of Soda Canyon from Cedar Tree Tower to Painted Kiva House, an instructive cliff dwelling about a quarter of a mile away, formerly practically inaccessible. To the west of the Mancos road about the same distance from Spruce Tree House as Cedar Tree Tower there is another tower of the same type, but with walls of adjacent rooms projecting above ground. Several other similar towers have been reported on the mesa, in the Mancos, McElmo, and Hovenweep Canyons, and elsewhere. The relation of a tower to kivas and other buildings of Square Tower House is shown in figure 108.

A preliminary examination was made of the ruin at Aztec Springs now called Yucca House National Monument, in the Montezuma Valley, with a view to future excavation and repair of this important site. As no satisfactory photograph of this ruin has ever been published a view of the Lower House of this ruin taken in 1874 by W. H. Jackson is by his permission given in figure 109. It is planned to begin work on the Lower House of this great ruin in the spring of 1921.

FIELD-WORK AMONG THE HOPI INDIANS

Dr. Walter Hough, curator of ethnology, U. S. National Museum, spent the month of June among the Hopi Indians of Arizona, a tribe with which he has been associated for 25 years. At present some of the Hopi tribes are making rapid progress toward assimilating the culture of the white man, while others; though becoming more and more affected, show changes to a lesser degree. As these changes have taken place through peaceful assimilation and were not forced by war or other disruptive agency they present an interesting field for ethnological research on normal modifications of social structures due to contacts. Some notes on this subject are appended.

Material Welfare

The Hopi have prospered during the last quarter of a century. From the period when they knew almost nothing of money the Hopi

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have advanced to a complete familiarity with United States currency. Purchases can be paid for with check. Some of the more advanced have bank accounts. The Hopi were always acquisitive and frugal, and their habits have put them in a rather good financial condition. Their agricultural products have had a better market and the prices are less subject to the former fixed low valuations of the local trader.

Social Changes

The most effective cause of social changes was the enforced attendance of children at government schools and the sending of children to distant Indian schools. Causing considerable friction at first, this has now been accepted in most cases as advantageous.

A result not previsedis the weakening of the clan discipline whose former regulative authority was silent but powerful. The weakening of this authority produced much laxity for a time and it was found necessary to appoint policemen and a "judge." The government found it necessary to send away girls not noticeably under parental discipline to schools until they should become discreet. This measure was quite opportune and had a beneficial effect.

Decay of Native Ceremonies

In this connection there is ensuing a rapid decay of native ceremonials. The heaviest loss to the native cult is felt by the death of the old men of a former generation. Very shortly there will be no one of the tribe who has not had training in school and more and more of these will evade the call of the native religion.

Some fraternities have suspended operation and others are very weak. Notably the woman's harvest ceremony at Walpi has passed out and the Snake Society there is about to discontinue.

Christianization

Missions to the Hopi were carried on from time to time during a period of several hundred years without appreciable results. When the disintegration due to government control had progressed missionary efforts began to bear fruit.

The Baptist mission at Polacca has a stone church and a considerable and growing number of converts. Other branches of this mission are doing well.

A slight cleavage is observed between the Christians and non-Christians but no friction. The Hopi are agreed to let things work out as they will.

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ARCHEOLOGICAL INVESTIGATIONS IN UTAH, ARIZONA, AND NEW MEXICO

During May and early June, 1920, Neil M. Judd, curator of American archeology, United States National Museum, continued his archeological reconnoissance of the arid region north of the Rio Colorado, Arizona, in behalf of the Bureau of American Ethnology. Attention was chiefly directed to the Toroweap Valley and several caves in an extensive lava flow on the east slope of Mt. Trumbull; to the unwatered mesa known as Pariah Plateau; to certain portions of House Rock Valley not previously visited[1] and to the upper two-

FIG. 110.—Ruin surmounting a circular butte of white sandstone near the eastern rim of Paria Plateau and not far from the Rio Colorado. Note the upright slabs in the foreground—a frequent feature of prehistoric dwellings in this region.

thirds of Bright Angel Creek. In addition, a number of caves in Cottonwood Canyon and Kanab Creek, Kane County, Utah, were examined for evidence of ancient habitations.

In Bright Angel Creek several open ruins and three groups of cliff houses were inspected; a complete survey was found impossible on account of unexpected high water which prevented access to the narrow, walled-in portion adjoining the Grand Canyon of the Colorado.

In contrast to the conditions which were encountered in this beautiful gorge, lack of water and forage for pack animals seriously

[1] Smithsonian Misc. Coll., Vol. 70, No. 2, 1918.

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FIG. 111.—Cliff dwellings on the west side of Bright Angel Creek, above the mouth of Beaver Creek. Through the doorway of the right-hand room will be seen a bench, made from a cottonwood log, which forms an unusual feature of the ruin.

FIG. 112.—A group of small storage cists near several ancient ruins at the foot of the upper falls, Ribbon Falls Canyon, Bright Angel Creek. The inaccessible cliffs surrounding this section of the canyon form an amphitheater whose narrow entrance was guarded by a second fall over one hundred feet in height.

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restricted investigations in the other sections above noted. The hurried inspection of the Mt. Trumbull region was made in an automobile, it being impracticable to use horses in this parched country during the summer months. Exposed pueblo ruins bordering the east rim of Pariah Plateau and overlooking the Painted Desert proved more numerous than was anticipated. In size, in arrangement of rooms and in the quality of their masonry these ancient dwellings are superior to those seen elsewhere in northwestern Arizona; likewise, potsherds examined at each site exhibit greater perfection of form and a higher decorative technique. These two factors—architectural

FIG. 113.—Part of a cliff village in a cave on the east side of Cottonwood Canyon, near Kanab, Utah. The village includes nineteen rooms and a nearby spring furnished excellent water for the ancient inhabitants.

and ceramic remains—alone are sufficient to connect the former inhabitants of this region with the pre-Puebloan peoples east of the Rio Colorado and to warrant the expectation that additional investigations will disclose the approximate points at which the Colorado River was crossed in ancient times.

Following his researches for the Bureau of American Ethnology, Mr. Judd proceeded to New Mexico as director of an archeologic reconnoissance of the Chaco Canyon National Monument. This survey was conducted under the auspices of the National Geographic Society and had for its prime object close examination of the aboriginal remains in the above monument with a view toward selec-

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tion of a possible site for exhaustive investigation and permanent repair.

The Chaco Canyon National Monument was created by presidential proclamation March 11, 1907, and includes 18 major ruins of very great significance in the study of ancient Pueblo life. Unlike the vast majority of cliff houses and other ruins found elsewhere, each of these huge buildings was constructed along preconceived plans

FIG. 114.—Grand Canyon of the Colorado from the lower Toroweap valley, southeast of Mt. Trumbull. Evidence of prehistoric habitations were not lacking in this region but the dwellings were widely separated and poorly preserved.

and as a community enterprise. The studied arrangement of their rooms and the perfection of their masonry rank them as the very finest examples of prehistoric architectural accomplishment in the United States. Not only did the ancient inhabitants of Chaco Canyon excel as builders with stone, but the lesser objects, found in and about the great communal dwellings, show that they had attained remarkable skill as makers of pottery, ornaments and implements of various

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FIG. 115.—The north wall of Pueblo Bonito, viewed from the northeast. This is the largest and justly the most famous of all the Chaco Canyon ruins; it covers nearly three acres of ground and some of its walls still stand to a height of forty feet. When occupied Pueblo Bonito probably contained as many as 800 rooms, sheltering over 1200 individuals.

FIG. 116.—The north-central portion of Pueblo Bonito, from the southeast, showing its position relative to the north wall of Chaco Canyon. Sections of fourth story walls appear in the above illustration. Like most of its neighboring ruins, Pueblo Bonito was constructed in a series of terraces overlooking a central court or plaza; the outer wall was pierced by small windows above the first floor but had few doorways.

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FIG. 117.—A portion of Kimmenioli ruin, showing the present condition of its walls. About 135 ground floor rooms are still traceable; originally the building was three, perhaps four, stories high. Although one of the finest in the national monument this great communal dwelling is not so well known as some of its neighbors in Chaco Canyon which is situated some ten miles to the north and east.

FIG. 118.—Pueblo del Arroyo, occupying an insecure position on the very edge of Chaco wash, 300 feet west of Pueblo Bonito. Flood waters have exposed the remains of an older dwelling beneath the walls of the larger structure and now threaten the latter. View from the north.

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sorts. The beauty and technique of such specimens warrant the belief that these canyon dwellers had reached a plane of esthetic as well as social development not surpassed elsewhere in the Southwest.

Although the 18 major ruins constitute the main feature of this national monument there are, in addition, hundreds of "small house" remains scattered throughout the entire Chaco Canyon district. In culture as well as in architecture these lesser dwellings were closely allied to the larger structures. Talus pueblos and small cliff houses are to be found along the north side of the canyon; elsewhere the mud walls of a "pit house" have been disclosed—a crude, semi-

FIG. 119.—Part of Pueblo Pintado, as seen from the northwest. This ruin was visited by Lt. J. H. Simpson, August 26, 1849, on his memorable advance into the Navaho country; the large timbers noted by Simpson and other early explorers have since been torn from the walls, causing obvious destruction to the latter.

subterranean shelter—older than any of the other habitations yet observed in this region. Certain it is that comprehensive investigations in the Chaco Canyon drainage will add largely to present knowledge concerning the prehistoric pueblo peoples of the southwestern desert country.

MUSIC OF THE PAPAGO AND PAWNEE

In February, 1920, Miss Densmore went to the Papago Reservation in southwestern Arizona to continue her study of Indian music for the Bureau of American Ethnology, residing for more than four

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weeks at a government station called San Xavier Mission. The Papago tribe was selected partly because of its desert habitat (fig. 120), the intention being to compare the phonographic records of Papago songs with those of Arabian songs obtained from Arabs who were temporarily in Washington, D. C. (Subsequent results proved the value of this comparison.) According to the last census there are 7,465 Papago Indians on the reservation, but not one "mixed-blood" family. It is said further that there has never been any intermarriage between this tribe and Mexicans or Spanish. Their manner of life is becoming modified, but many primitive customs remain and were observed. A primitive burial place was found by Miss Densmore.

FIG. 120.—Habitat of Papago Indians. (Photograph by Miss Densmore.)

These burial places were constructive on the side of a mountain and consisted of low walls of rocks, roofed with timber and tightly closed with stones. Bodies were removed after a time to make room for other burials. A skull and a few bones remained in the tomb examined.

The subjects studied were: (1) Songs used in treating diseases caused by spirits of dead Apaches and Papago; (2) songs connected with the "purification" of returned warriors who had killed Apaches, and (3) songs connected with dreams, games, and dances. Musical instruments formed a subject of special investigation. A native flageolet was obtained (fig. 12) together with the tradition concerning its origin. The music of this instrument was phonographically recorded and has been transcribed. The Papago beat upon an over-

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FIG. 121.—Papago playing on native flageolet.

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turned basket instead of a drum, striking the basket with the palms of one or both hands. "Rasping sticks" are sometimes used with such a basket, as shown in figure 122.

FIG. 122.—Papago and native musical instruments.

After a brief stay in Phoenix, Arizona, Miss Densmore went to Camp McDowell (formerly Fort McDowell) and was present at a

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gathering of Mohave Apaches, explaining her work and securing their consent to record songs on a subsequent visit. The adobe buildings of the old fort are in ruins, but a few of the smaller and more substantial buildings remain.

From Arizona Miss Densmore went to Pawnee, Oklahoma, arriving April 12, a few days before the Morning Star Ceremony. This is one of the most important ceremonies of the year as it is held for the purpose of securing good crops. At this time the "Morning Star Bundle" is opened and its contents displayed for several hours, while the proper rituals are sung. Miss Densmore was allowed to enter the lodge for a brief time and to view the sacred articles (it is said

FIG. 123.—Pawnee lodge of Morning Star Ceremony. (Photograph by Miss Densmore.)

only one other white person has been accorded this privilege). During the remainder of the ceremony, which lasted many hours, she stayed outside the lodge (fig. 123) and make manuscript notes of the songs. An approach to two-part music, heard at this time, had not been previously observed. While at Pawnee a sufficient number of songs was recorded to complete the musical study of that tribe.

In November, 1920, Miss Densmore returned to Arizona to resume work among the Papago. The principal work was done at Vomari, a point near the Mexican border and 80 miles from the railroad. Interesting material was collected also at Sells, formerly known as Indian Oasis. Among the subjects studied were: (1) The Papago expeditions to the Gulf of California for salt and for "medicine power,"

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each sort of expedition having its songs; and (2) the rain-making ceremonies, including the manufacture of tizwin. In connection with the latter a visit was made to Santa Rosa, at the extreme north of the reservation, where a tizwin camp and lodge were photographed. A specimen of the cactus syrup used in making tizwin was obtained, as well as a large basket which had been used in serving this wine.

Many sites of legendary or geographic interest were photographed, Miss Densmore travelling more than 360 miles by auto on this trip.

The most important result of this expedition was the hearing of a form of three-part music at a Papago dance. This was said to be a native musical custom. So near an approach to polyphonic music has not been hitherto observed by Miss Densmore and the subject will receive further investigation.

OZARK CAVES AND MOUNDS IN MISSOURI

During the summer of 1919 the work of cave exploration in the Ozark region was continued by Mr. Gerard Fowke, for the Bureau of American Ethnology. Almost his entire time was given to a thorough examination of two large caves in Pulaski County. The first, known as Miller's cave, is three miles northeast of Big Piney postoffice. The opening is in the vertical face of a high cliff fronting Big Piney River, with a steep talus slope beginning 30 feet below the floor of the cave and extending to the water's edge. The perpendicular wall below, with a projecting ledge which forms the roof, prevents a direct entrance, and the interior can be approached only through another cave whose opening is in a ravine near by. A narrow passage, barely large enough to admit a man in a crawling or crouching position, connects the two, and it is only through this that access can be gained to the main cave. The inmates were absolutely safe from molestation, as one man could defend this opening against any number. A little stream flowing along the foot of the east side of the cavern ensured a supply of water at all times: game was plentiful in the neighborhood: the river abounded in fish; and fertile, level bottom lands, easily cultivated, on either side of the stream furnished much corn and other farm products.

A ditch and enbankment across an isthmus guarded a peninsula on the opposite side of the river, and on both sides low house mounds and abundant debris furnished proof of two large village sites. Whether there was any connection between the villages and the cave dwellers cannot be determined.

A bed of clean, pure ashes whose depth ranged from 3 to 6½ feet, according to the irregularities of the clay, was found in the cave

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reaching from wall to wall, a width varying from 45 to 70 feet. This bed was so loose as to be almost like a snow bank; but for the most part they were as compact as if much trampled over while wet. When solidly packed, the mass would measure fully 800 cubic yards in volume; but when loosened by excavation, 200 cubic yards more. All the wood had to be carried from either the top or the bottom of the hill, which is about 400 feet high, and passed through the small opening from the other cave. It is safe to say no more fuel would be used than was strictly necessary. When it is considered how little fire is requisite for the needs of an Indian household, and that the limited space suitable for residence would not provide sufficient room for more than half a dozen families at a time, it is quite clear that this amount of ashes meant a very long occupancy. Even with continuous habitation, several centuries would be required for such a quantity to accumulate; and if residence was desultory and intermittent, as is customary with roving or hunting tribes, or if it was only a winter home for some of those living in the villages mentioned, the period would be greatly lengthened. Yet the remains found in these ashes were of the same character from top to bottom. The artificial objects found numbered about 75 mortars, more than 200 pestles, hundreds of flint knives or spear heads, numerous implements of bone, antler, and shell; quantities of crude pottery fragments, a few tomahawks, and two pipes. While the many mortars and pestles indicate much use of grain, seeds, and nuts, at the same time the great amount of mammal, bird, and fish bones showed that a large part of their sustenance was derived from animal food. Of more than 20 skeletons found in various stages of decay, only two were of aged individuals, most being remains of children or young persons. The skulls were of low type. Not an ornament of any sort was found except a few rude ones of bone or shell. Some of the human bones, mostly those of children, were charred and broken, and mingled with the debris of food animals and ashes as if the flesh had been used for food, and the broken bones thrown aside with the refuse. There was no evidence of the cremation of bodies; the condition of these bones points to the practice of cannibalism.

The second cave explored is situated a mile south of Waynesville, on land belonging to Dr. J. W. Sell, and was probably a temporary camping place. Its opening is on a hillside facing Roubidoux creek, and is easily accessible from either the top or the bottom of the hill. A few rods back from the entrance, water stands on the floor throughout the year: so that only the front part of the cave was used for shelter. At the entrance is a pile of earth washed from the sloping

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surface of the hill above, over the ledge that forms the roof. This accumulation spreads for 50 feet into the cave, but not so far on the outside, because there it washes down the slope. From its surface to the clay floor on which it rested the greatest depth was a few inches over six feet. From top to bottom there was found in this cave the ordinary debris of an Indian campfire. Buried at various depths here and there, in the portion within the cave were 14 human skeletons, most of them so decayed that only a few fragments were remaining. They are of persons of various ages; some of the skulls were low, small, and flat.

A long period of occupancy is indicated by the conditions here as at Miller's cave. While the amount of earth heaped in front of the cave does not seem large, yet it all has come from a space not exceeding 6,000 square feet in area and most of this is bare rock with humus of decayed vegetation existing only in the crevices or on the few flat surfaces. All the other water from the hill runs to the slopes and does not reach the cave. A violent storm passed over the region soon after the work was concluded, in which 12 inches of rain fell in three days, yet not more than a wheelbarrow load of soil was washed down over the roof to the pile already there. It is evident that centuries would be required to build up the mass, throughout which these traces of man's presence are scattered promiscuously.

During all the period these caves were in use no improvement took place in the fabrication of stone implements or pottery. Specimens found nearest the top of the ashes or dirt could not be distinguished from those of the same class from the rock or clay floors. The inhabitants remained in the same plane of culture.

The thousands of small mounds extending southward from the upper swamp region of Missouri have long been a puzzle to archeologists and until recently it has been supposed that in this state they are confined to the southeastern portion: but in the course of Mr. Fowke's field-work they have been found to extend to the north and west as well. Groups of them have been located in Oregon, Dent, Phelps, Pulaski, Osage, and Morgan counties, the latter along the Benton County line. Their purpose has not yet been determined, although Thoburn's hypothesis that they are due to the Pawnees, whose line of migration was through the area in which they occur, and are the remains of earth-covered houses, seems the most tenable yet advanced. This theory implies that when this tribe passed beyond the region in which suitable timber for supporting the weight of the earth, and also earth adapted to such use, could be procured, they were compelled to substitute for them small poles overlaid with grass.

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Comparison with the typical modern Pawnee earth lodge, a photograph of which Miss Densmore published in her account of field-work for 1919, corroborates Thoburn's interpretation of these Missouri mounds.

ARCHEOLOGICAL RECONNOISSANCE IN HAWAII

With an allotment from the Bureau of American Ethnology, Mr. Fowke spent the entire summer of 1920 in the Hawaiian Islands, making a careful examination of all ancient works of whatever nature, that could be visited with the time and opportunities at his command.

While there is abundant evidence everywhere that the old Hawaiian people were extremely industrious, using vast quantities of stone in

FIG. 124.—Pawnee ceremonial earth lodge, exterior. Photograph by Miss Densmore.

the construction of their temples, houses, garden enclosures, fish ponds, and taro terraces, there was nothing discoverable among all these remains which could be attributed to a prehistoric tribe, or to any other race than that found in possession when the islands were first known to the white man.

The five principal islands were visited and explored as thoroughly as was possible in the circumstances. It was not practicable to examine every feature of interest, where there is so much demanding attention; but at no place could there be discovered any indication which would seem to justify excavation with the expectation of un-

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earthing beneath the top soil remains which might differ in general character from those on the surface. There being no difference between remains belonging to the historic period and those superficially showing evidence of great age, it is logical to conclude that when that branch of the Polynesian race, now known as Hawaiians, left their home in the distant South Seas and migrated to these islands, they found the territory without inhabitants; and there is no reason whatever for supposing that any people culturally different from the historic Hawaiians had ever previously lived on the islands.

FIELD-WORK AMONG THE FOX AND PLAINS CREE INDIANS

Dr. Michelson, ethnologist of the Bureau of American Ethnology, began field-work among the Fox Indians at Tama, Iowa, about the

FIG. 125.—The dwelling in which the White Buffalo Dance of the Fox Indians is held. The building is the typical "bark" house used by the Fox in the summer and early fall.

middle of June. His main purpose was to restore phonetically a text containing the autobiography of an Indian woman written in the current syllabary which he had obtained in the summer of 1918, to correct the translation where there was need, to elucidate some ethnological references contained in the text, to clear up some grammatical obscurities, and to work out the verbal stems so far as was feasible in the field. All this was successfully accomplished, and Dr. Michelson left for Saskatchewan in the latter part of July for a preliminary investigation of the Plains Cree. The results of this investigation show that the Plains Cree are tall and have a cephalic index

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FIG. 126.—An aged Plains Cree (File Hills Agency).

FIG. 127.—Tipi of the Plains Cree (File Hills Agency).

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of about 79, and evidently are the same type as the one which formerly occupied the Mississippi Valley, thus confirming the results of Dr. Boas, announced in 1895. The general grammatical principles which have been worked out for Fox apply also to Cree. In some respects Cree is more archaic than Fox, in others less so. Ethnologically the Plains Cree are about half way between more typical Indians of the Plains, such as the Blackfeet, and the Central Algonquins. An analysis of the myths and tales which cluster around the culture hero shows that we practically have the myths and tales of the culture heroes of the Blackfeet and Ojibwa combined. All this is just what one would expect from the geographical position of the Plains Cree.

ARCHEOLOGICAL EXPLORATIONS IN TENNESSEE

Mr. W. E. Myer, of Nashville, Tenn., spent September and October, 1920, making explorations for the Bureau of American Ethnology in the Cumberland Valley around Nashville. He discovered on the H. L. Gordon farm, one mile northeast of Brentwood, in Davidson County, the remains of an ancient Indian walled town. These were situated in a woodland and had never been disturbed by the plow. Their partial exploration brought to light some new and interesting details of the life of the inhabitants. Traces of 87 house circles and faint indications of several more could be made out. This town covered 11.2 acres and was surrounded by an earthen embankment which formerly supported a palisaded wall, equipped with circular towers every 55 feet.

The ancient inhabitants, for some unknown reason, had deserted this village and the site had never afterward been occupied or disturbed. The deserted structures had gradually fallen down and the remains slowly buried under from 10 to 14 inches of earthmold. In some of these circles portions of beautiful, smooth, hard-packed, glossy-black floors were found. In the centers were the ancient fire-bowls, yet filled with the ashes of the last fires kindled in these homes before their owners left them forever. Near these fire-bowls often could be seen the metates, mullers and other household utensils, just as left the last time used. Underneath the floors were the stone slab graves of the little children, one of which is shown in figures 128 and 129.

A level open space was found near the center of the town and on the western side of this plaza was a low flat-top mound that had originally supported some important building. Adjoining this mound

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on the west was an earth circle which probably outlined the ruins of the town house. At the center of this sacred structure, on the unique black glossy floor, an ancient altar (fig. 130) was found. It was still filled with the pure white ashes of what had once been the sacred fire.

FIG. 128.—Child's grave after removal of infiltrated soil, before disturbing mortuary vessels.

This altar was carefully preserved and is now in the Bureau of Ethnology. The Gordon site is of much interest because here we have an ancient Indian village just as the original inhabitants left it.

THE FEWKES GROUP

Mr. Myer also partially explored an unnamed Indian village group at Boiling Spring Academy in Williamson County, Tenn. At the

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request of many citizens of Tennessee Mr. Myer named this site the Fewkes Group, in honor of Dr. J. Walter Fewkes, who had visited it and recognized its possibilities a few months before.

FIG. 129.—Child's grave after removal of body. Note floor composed of broken pottery.

At least two different peoples have lived on this site. The earlier people built the mounds and most of the other remains. At a later date a small band of some other tribe located here. The earlier people buried their dead either in hexagonal or almost circular stone slab graves, the bodies closely flexed. The later band used rectangular stone slab graves with the body extended full length on its back.

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The Fewkes Group consists of four mounds, one on each of the four sides of a level plaza, the traces of about a dozen house circles, and a small remnant of what was once a considerable stone slab cemetery.

FIG. 130.—Altar.

Mound No. 2 on the map is a low oval mound situated on the western side of the plaza. The site of this mound had been lived upon for some time before any mound was raised. At last the mound was commenced and raised to a height of three feet and a building for domestic purposes erected thereon. This building was later torn down and then the mound was raised three feet higher. The mound was again used for domestic purposes for a period. Then a town house

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or sacred ceremonial house was built on it. This sacred building also had one of those rare, beautiful floors made of clay, smoothed, then hardened by fire, and finally covered with a coating which is yet black and glossy. In the center of the building, on this beautiful floor, an altar was found. It was similar to the altar shown in figure 130.

This building had walls made of cane stalks with the leaves attached, which had been woven in and out between the upright posts which supported the roof. These canes may have had a coating of earth, though no trace of it could be found, and the walls also had a

FIG. 131.—Mortuary vessel from child's grave.

covering of woven cane matting. In some way the building was destroyed by fire. Earth was thrown on the remains in time to smother its still glowing embers, which produced a large amount of powdery charcoal containing fragments of cane stalks with the leaves attached, and portions of the woven cane matting. After this sacred building was burned the mound was raised one and one-half feet or more in height. All trace of its last use has been destroyed by 85 years of cultivation.

The low mound, No. 3, on the south side of the plaza, was a burial mound belonging to the first settlers. The mortuary vessel shown in figure 131 came from a hexagonal grave in this mound.

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Mound No. 1 on the north side of the plaza is 180 feet across the base and 25 feet high. It is the most conspicuous mound in the group. Lack of funds prevented its exploration.

House circle No. 6 was one of the group of buildings, Nos. 6, 10, and 11, whose functions were doubtless closely interwoven. No. 6 contained in its center an altar or fire-bowl.

There was evidence that this town had either been taken by an enemy and burned, or the ancient inhabitants, forced to flee, had burned their homes to prevent their falling into the hands of the invader.

FIG. 132.—House circle No. 17. Cleared floor of wigwam, showing ancient fire-bowl. Body of child was found by side of upright stone. Its head rested within edge of fire-bowl. Top edges of upright stone slab sides of another coffin in corner to right of women.

House circle No. 17, shown in figure 132, was a typical dwelling. It was evidently the home of a neat housekeeper. No broken animal bones, pottery, fragments, or other evidences of untidiness littered the floor. The floor was of hard-packed clay and a fire-bowl was sunk in the center of the floor. At this fire-bowl a puzzling burial was unearthed. A child, about eight years of age, was buried by the side of the upright stone slab, with its head resting just within the extreme edge of the fire-bowl, whose rim had been cut away at this point to admit the top of the child's head. The fire-bowl was found still filled with ashes, and although the ashes covered the top

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of the child's head, the head showed not the faintest trace of the action of fire. The graves of two infants were also found in the floor of this house.

At both the Gordon and the Fewkes groups every piece of bone and every fragment of pottery was carefully saved and location noted. These thousands of fragments will give a reliable record of the food animals and practically a complete list of all the sizes, colors and shapes of their domestic pottery.

Both these sites, when explorations were completed, were accurately restored to their original shape for the benefit of coming generations. The interesting altars, fire-bowls, building post-holes, and vestiges of domestic life were carefully preserved, and again covered up so as to allow their future study. It is strongly urged by the citizens of Tennessee that the Fewkes Group be made a national monument.

Mr. Myer discovered a great Indian fortress on the long, narrow point of land between the Harpeth and Cumberland rivers, at their junction, in Cheatham County, Tennessee. This fortress consists of a thin, double-faced bluff, about three-quarters of a mile in length, and only from 10 to 250 feet wide along its tall and narrow summit. It faces both rivers and has nearly perpendicular sides along its entire length on both streams. It can be scaled with very great difficulty and at only a few places. The Indians protected these few places of ascent with breastworks or mounds. This was a central place of refuge for a series of scattered Indian settlements extending about six miles up and five miles down the Cumberland River and about five miles up the Harpeth.

The four pipes from this region are unlike any found elsewhere in the valley, and probably the culture of the ancient people who used this fort was different from any other known at present in the Cumberland Valley.

On a recent visit Dr. Fewkes examined the great unexplored mound group on Harpeth River at the mouth of Dog Creek, in Cheatham County. This group is the remains of one of the important prehistoric settlements east of the Mississippi.

There is a great mound, with wide earthen platforms, capping a hill in the up-stream end of this settlement. A portion of the hill has been artificially shaped so as to give greater prominence to the works on top of it. Surrounding these works on the summit are the ruins of a large edifice and other important remains. This portion of the settlement covers about 40 acres and is said to be connected by an embankment with the remainder of the mounds in Mound Bottom,

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about two miles down the Harpeth. The Mound Bottom portion, shown in figure 133, covering about 50 acres, contains Mound No. 2 with large platform; Mounds Nos. 1, 4, 5, and 6; cemetery No. 7, and other traces of a considerable population.

FIG. 133.—Mound Bottom. Other great mounds belonging to this unexplored group.

ARCHEOLOGICAL EXPLORATIONS IN NEW MEXICO

During July, and a part of August, Mr. J. A. Jeancon, special archeologist of the Bureau of American Ethnology, made a reconnoissance and conducted intensive archeological work at Taos, New Mexico. While it has been known for a long time that there was excellent archeological as well as ethnological material to be obtained in this valley, no archeological research has been done there before the present work in the summer of 1920.

The great number and variety of sites seem to indicate a long period of occupancy of the region. These sites are well-defined small house groups, each indicating one, two, or more rooms. There are also great communal groups as that at Bagley ranch and the Arroyo Hondo. The mounds are sometimes over 20 feet in height; the pottery sherds scattered over these sites range from the primitive black-and-white ware to what appears to be the so-called biscuit ware.

A small pueblo ruin at Llano was selected for excavation and, while the yield of pottery was small, many interesting facts were obtained. The ruin is located on the south bank of the Little Rio Grande, one mile and a half from the plaza of Ranchos de Taos. Situated on the edge of a high mesa it commands a magnificent view of the country for miles around, excepting to the east, where the view is cut off by

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the mountains. The fields which probably furnished the villagers well-watered agricultural areas are situated in the valley below.

The excavation showed that there had been two occupations on the site. In several places the remains of earlier old walls show beneath the present walls, indicating that the first and second buildings had

FIG. 134.—Ruin at Llano, Taos Valley.

totally different ground plans. All of the walls (fig. 134) were made of a mixture of wood ash, small stones (about the size of pebbles ordinarily found in gravel), and adobe which when exposed to the air becomes very hard. The walls of the second occupation are not as well made as those of the first, but the floors of both resemble those of the older villages still inhabited, where the blood of animals was used to give them temper and polish.

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The general plan of the ruin recalls those of southwestern Colorado. The kiva at Llano (fig. 135) was completely surrounded with rooms and when the roof was intact its surface was a small plaza surrounded by the buildings of the main group. An evidence of the two occupations is that the more recent kiva was built inside the older, and the space between their walls had been filled in with rubbish. No roof timbers remained in the ruin, but there were in the kiva four upright posts upon which the former roof rested. In about the center of the kiva there was an excellent fireplace, and in the floor directly

FIG. 135.—Kiva at Llano, Taos Valley.

adjoining the fireplace a plastered pit (fig. 135), an unusual adjunct to the fireplace, the purpose of which is unknown. Between the fireplace and the pit is a stone slab, one foot high and about nine inches wide. The excavations brought to light a very small number of the undecorated sherds of white ware; the black-and-white pottery is unusually hard and fine, but the black or rather brownish-black ware used for cooking and storage is very soft. The forms of and designs on the black-and-white pottery strongly suggest the San Juan ware.

During the month of May, 1920, Mr. Jeancon made a satisfactory reconnoissance in the country lying south and southwest of Dulce,

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FIG. 136.—Ruin in La Jara Canyon.

FIG. 137.—Ruin in La Jara Canyon.

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New Mexico. He found in Burns, La Jara and other canyons indications of two periods of occupation evinced by the pottery which belongs to the old pre-Spanish black-and-white and the hard-coiled wares. The houses of the earlier period were "earth lodges" of a primitive type. The house remains point to the second occupation and are in many cases built on the tops of high masses of sandstone (fig. 136), and show the crudest workmanship. A common site for buildings is the edge of high points (fig. 137), along the terraced (natural) sides of the canyons. All of the later sites give

FIG. 138.—Dulce Ruin.

an impression that they were more or less defensive and hastily erected. Associated with these buildings are remains of metal objects, apparently of Spanish manufacture; many of the beams in the houses plainly show the marks of metal tools. The pottery has a bluish-black color, closely resembling a modern vitrified brick, and is so hard that when struck it rings with a clear bell-like tone. The surface suggests old Hopi ware and the decorations are similar to the older Zuñi and Acoma designs.

The pottery and associate remains probably do not antedate the reconquest of the Southwest by the Spaniards in 1690. It is known that some of the pueblo people fled from the Spaniards at the time of

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the great rebellion and took refuge in the mountains to the north. It is probable that further investigation will show that in this area the ruins ascribed to the second period were built and inhabited by refugees from Zuñi and Acoma.

ARCHEOLOGICAL EXPLORATIONS IN EASTERN TEXAS

Archeological field-work was carried on in 1920 by the Bureau of American Ethnology in co-operation with the University of Texas under direction of Professor Pearce and Professor Engerrand. Several localities in Texas were visited and considerable intensive work done in the eastern part of the state.

The region in eastern Texas to which most attention was given was in the vicinity of the little city of Athens in Henderson County. Judge A. B. Watkins of that city has long taken a keen interest in the history and archeology of the region and was of great help to Professor Pearce in his field-work. A number of aboriginal objects, complete specimens of pottery, clay pipes, conch-shell cores, fine arrowheads and human bones were obtained from an ancient burial ground two miles northeast of Frankston on the De Rossett Farm. One of the objects found was a "turkey call" or whistle made from the drumstick of a turkey. This is identical with those used not many years ago by old white hunters on the frontier and Professor Pearce feels sure that the white man's use of this device was borrowed from the Indian. Professor Pearce finds that the east Texas region contains numerous mounds, village sites and burial places, among which may be mentioned Nacogdoches, Panola, Bowie, Wood and other counties.

Three interesting mounds on the Morrall Farm four miles east of Cherokee County were investigated. The highest of these mounds has an altitude of about 35 feet above the level valley or field in which they are all located and is about 80 feet across at the base. This mound is very steep and even now after long erosion its sides rise at an angle of 45°. Mound B is 180 feet long by 75 feet wide and rises only 15 feet above the general level. The other three mounds in the vicinity of Athens have been ploughed into and have no regularity in form.

On the Quate tract east of De Rossett farms there are Indian mounds which were not regarded as very ancient. Several mounds situated in Harrison County on the farm of Mr. Lane Mitchell, of Marshall, were examined and remains of earth lodges with central fire pits were reached. These mounds are probably very ancient.

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Numerous other sites were explored, yielding a collection of pottery, stone implements and other objects, illustrating the life of the prehistoric aborigines of eastern Texas.

Everything found implies that the Indians of this region lived in relatively settled villages, had considerable agriculture, made pottery extensively and of a high-grade, and were altogether in a considerably higher stage of culture than were those who occupied the prairies and plains.

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THE CIRCULATORY SYSTEM IN BONE

WITH SIX PLATES

BY
J. S. FOOTE, M. D.

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THE CIRCULATORY SYSTEM IN BONE

By J. S. FOOTE, M.D.

Professor of Pathology, Medical Department of Creighton University, Omaha, Nebraska

(With 6 Plates)

INTRODUCTION

This article on the circulatory system in bone is the result of a continued study of the comparative histology of bone published in a monograph entitled "A Contribution to the Comparative Histology of the Femur," Smithsonian Contributions to Knowledge, Vol. 35, No. 3, 1916.

In that monograph were described the structural bone types and the type combinations as they were observed in cross sections of the femora of various animals from amphibians to and including man.[1] The circulation within the bone substance was not seen at that time, as cross sections do not show it properly.

In 1919 a casual preparation of a tangential section of the femur of a domestic turkey disclosed a very remarkable circulation in the bone substance and it was this disclosure that led to further examination of tangential sections of the bones of different animals, the drawings and descriptions of which are here presented.

Later (1919-20) the structure of and circulation in the bone of the fish, as seen in the Mascalonge, Esox, were studied, compared with the bone types of later vertebrate animals and added to the list of bones examined.

THE CIRCULATORY SYSTEM IN BONE

The circulatory system in bone, as usually described, is limited to the blood vessels of periosteal membranes, medullary canals and diplöe of long and cranial bones respectively, little being known about the circulation within the bone substance itself.

The circulation described in this article is situated in the bone substance of the mandible and cranial bones of the fish, Mascalonge, Esox, in the walls of the long bones of the amphibian, reptile, bird,

[1] Number of sections of femora described and drawn in the monograph, 440.

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bat, other mammals and man, in the cranial bones of man, in the inner wall of the 9th rib and in the infra- and supra-spinous fossae of the scapula of man. The blood supply of the lower jaw and cranial bones of the fish is derived from the dermal vessels which enter the bone at various points and assume parallel positions in the bone substance, while the blood supply of the long bones of the higher vertebrates comes from two sources, viz. the periosteal vessels which send off many small branches into the bone through entering canals (canals of Volkmann and other canals), and the medullary arteries which pass obliquely through the walls of the shafts into the medullary canals where they divide into ascending and descending branches from which small vessels are sent off into the walls of the bones and here become continuous with the vessels from the periosteum.

The blood supply of the flat bones, such as the cranial, is derived from the vessels of the pericranial and endocranial membranes which send off branches into the outer and inner tables of these bones communicating by way of the central medullary diplöe.

From a study of a large number of bone sections [2] there are found to be three structural types and various type combinations [3] which enter into the formation of bone: these are the first, composed of lamellae; the second, composed of laminae; and the third, composed of Haversian systems. These three types are combined in various proportions in the bones of different animals. The circulations which are found to be present in the different types of bone also present variations which are sufficiently distinctive in character to form two circulatory types, viz., the branching, and the plexiform. The branching type, composed of tree-like branches, is found in the first type bones, the plexiform, composed of small, large and irregularly shaped meshes enclosed by small vessels, is found in the second and third type bones, while combinations of the branching and plexiform circulations are present in structural type combinations.

In the demonstration of the circulations some difficulty arises in the preparation of the bone slides. In small animals like the frogs or other animals of the same size it is practically impossible since the long bones are almost always round and tangential sections of them are necessarily flat. In large animals the long bones have flat areas of sufficient extent to make satisfactory slides.

In the preparation of bone sections for the purpose of showing the circulation, a flat surface of bone is selected and as large a piece as

[2] Number of sections of bones examined up to the present, 1000.

[3] A Contribution to the Comparative Histology of the Femur, by J. S. Foote, M. D., Smithsonian Contr. to Knowl., Vol. 35, No. 3, 1916.

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possible is sawed out, tangential to the diameter of the bone, and ground down to a suitable thinness which is determined by the appearance of the circulation.

It is not the thinnest possible section, measured in microns, that is most desirable, but one of sufficient clearness to show the circulation. During the grinding process it is necessary to examine the section at short intervals in order to ascertain just when to terminate the process.

The following sections taken from the bone of fish, amphibian, reptile, bird, mammal, and man have been studied, described, and drawn for the purpose of showing the structure and the circulation which belongs to it.

CROSS AND TANGENTIAL SECTIONS OF THE LOWER JAW AND TANGENTIAL SECTION OF THE CRANIAL BONE OF THE MASCALONGE, ESOX, A FISH OF WISCONSIN WATERS

CROSS SECTION OF A PORTION OF THE LOWER JAW

PL. I, FIG. 1A

The section is composed of parallel disks of bone substance situated between vascular channels or clefts. The bone substance does not show the presence of lacunae with their canaliculi. Very minute parallel canaliculi extend across the disks from one channel or cleft to another. A wave effect is given to the section by the undulating forms of the clefts. This arrangement of channels in the bone substance produces a very fine channel circulation. At short intervals within the clefts, as at C, figure 1, plate 1, may be seen small objects from which radiate minute canaliculi presenting the appearance of the canaliculi radiating from their lacunae, but these are in the vascular clefts and not in the bone substance.

TANGENTIAL SECTION OF A CRANIAL BONE OF THE MASCALONGE

PL. I, FIG. 1B

In this section are seen parallel rows of objects of various shapes situated in the bone substance. Some of them are circular with dark crescents on one side, while others are very irregular in shape. No canaliculi extending outward from them can be seen. For this reason they cannot be lacunae in the bone substance, as osteoblasts occupying such lacunae would be without a blood supply. On account of their general circular character these objects appear to be different sections of the vascular clefts of the bone and if any bone-producing cells are present they must be within the vascular clefts.

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CROSS SECTION OF ANOTHER PORTION OF THE LOWER JAW OF THE MASCALONGE SHOWING THE EARLY DIFFERENTIATIONS OF HAVERSIAN SYSTEMS

PL. 1, FIG. 2

These are small vascular canals surrounded by clear areas—in some instances lamellated, in others, homogeneous. Between the vascular canals is the bone substance with very fine channels. The vascular canals with surrounding clear areas become Haversian systems as vascular differentiation progresses. This early form of Haversian differentiation has a wide distribution since it is found in bone sections from fish to and including man. It is much more prominent in the lower orders of vertebrates than in the higher. Thus two early phases of the circulation are found in the bone of the mascalonge, viz., the channeled and early Haversian differentiation.

TANGENTIAL SECTION OF THE INNER RIDGE OF THE LOWER JAW OF THE MASCALONGE SHOWING THE BLOOD VESSELS

PL. 1, FIG. 3

The blood vessels vary in size. They are parallel with each other. Some are branching. Around the outside of their delicate connective tissue walls are seen fine plexuses of nerves. Between the vessels is seen a fine channeled bone substance without lacunae.

CROSS AND LONGITUDINAL SECTIONS OF THE FEMUR OF A MEDIUM SIZED BULLFROG, RANA CATESBEIANA

(The large, medium sized and small bullfrogs have different degrees of bone differentiation.) [4]

CROSS SECTION SHOWING THE STRUCTURE

PL. 1, FIG. 4

The type of bone is an early first. The inner wall is composed of bone substance in which are radiating, vascular, bush-like channels extending from the external to the internal circumferential lamellae and between which are round or oval lacunae with short branching canaliculi embedded in the bone substance and communicating with the bush-like radiations by means of their canaliculi. The bush-like vascular radiations appear to be segmented in some instances due to their oblique positions and the plane of the cross section. In the outer wall these radiating channels are absent and the bone is composed of lamellae with oval lacunae and radiating canaliculi.

[4] *Idem.*

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LONGITUDINAL SECTION OF THE SAME FEMUR SHOWING THE CIRCULATION

PL. 1, FIG. 5

The oblique entering canals in the shafts of the femora of bull frogs, for the passage of the medullary arteries, are found in the bone of the large and medium sized but not in the small animals. As the femur of the frog is small and round the circulation in a tangential section could not be seen. The general plan, however, is shown in a longitudinal section of the inner wall as represented in figure 5, plate 1. The letter C is placed at the center of the shaft. In this wall are two sets of six or seven oblique vascular canals entering the shaft from the periosteal surface and united in such a manner as to form slanting m-shaped converging loops. These loops, beginning near the extremities of the shaft, converge toward the lineal center and medullary surface. From these loops and their stems minute canaliculi are sent off into the bone substance where they communicate with the lacunae. Between the two sets of converging loops are short segments of loops extending across the wall transversely. In the outer wall the loops are not seen in longitudinal section nor are the radiating vascular channels seen in the cross section of this wall.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF THE REPTILE, ALLIGATOR MISSISSIPPIENSIS

CROSS SECTION SHOWING THE STRUCTURE

PL. 1, FIG. 6

This section is composed of three wide, concentric rings of incompletely differentiated Haversian systems alternating with two narrow, concentric laminae. The vascular canals surrounded by clear areas similar to those seen in the bone of the fish are early forms of Haversian systems. The laminae are more advanced in differentiation than the Haversian systems. The bone, as a whole, shows an early second and third type structure.

TANGENTIAL SECTION OF THE SAME FEMUR, SHOWING THE CIRCULATION

PL. 1, FIG. 7

The circulation is in the form of a vascular plexus. The section is situated below the periosteal surface near the posterior ridge. Several entering canals, without surrounding lamellae, are seen in

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cross section in the bone substance through which periosteal vessels pass into the bone. The vascular plexus is very extensive and has a general longitudinal direction. The meshes are irregular in size and shape. In some portions of the section vascular expansions are found. The blood vessels are round and occupy similarly shaped channels in the bone substance. They are composed of very thin connective tissue walls, without smooth muscle, and are striated spirally and longitudinally. The exact purpose of the vascular expansions is not clearly understood. They are found too frequently to be accidental, and, as will be noted later, are more prominent in the branching than in the plexiform types of circulation. They may have an important physical value.

CROSS AND TANGENTIAL SECTIONS OF A SECOND TYPE BONE OF BIRDS AS SEEN IN THE FEMUR OF A DOMESTIC TURKEY, MELEAGRIS GALLOPAVO

CROSS SECTION SHOWING THE STRUCTURE

PL. 1, FIG. 8

The section is composed of concentric laminae separated and crossed by vascular canals. The wall of the bone is divided into nearly equal segments by large radiating canals extending from the medullary canal to the periosteal surface. From these canals are sent off lateral, small, parallel canals which divide the wall of the bone into laminae. The laminae are interrupted in the anterior wall and posterior ridge by incompletely differentiated Haversian systems. It was the femur of the turkey which first called attention to the variations in structure and circulation.

TANGENTIAL SECTION OF A FEMUR OF THE TURKEY, SHOWING CIRCULATION

PL. 1, FIG. 9

This section consists of a very rich, small-meshed plexus of vessels situated between the laminae and having a general longitudinal direction. In the central portion of the section two plexuses can be seen, one above the other, with a lamina of bone between them. This is one of the most extensive circulations observed in long bones and with such a blood supply as is here shown, this becomes a vascular organ of great importance.

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RECONSTRUCTION OF A SECOND TYPE BONE WITH ITS INTERLAMINAR CIRCULATION

PL. 2, FIG. 10

This figure shows a reconstruction of a second type bone with its circulation. The drawing represents three concentric laminae with two interlaminar plexuses of blood vessels. The vessels are uniform in size, composed of thin connective tissue walls and the vascular expansions are not at all prominent. It is difficult to understand why such a rich blood supply should be required in bone for its nutrition.

CROSS AND TANGENTIAL SECTIONS OF AN EARLY DIFFERENTIATION OF A THIRD TYPE BONE IN BIRDS AS SEEN IN THE FEMUR OF A TURKEY BUZZARD, CATHARTES AURA SEPTENTRIONALIS

CROSS SECTION SHOWING THE STRUCTURE

PL. 2, FIG. 11

This bone is more advanced in differentiation than that of the domestic turkey since it is composed of third type structural bone units instead of the second. These units are enclosed between the external and internal circumferential lamellae and form nearly the whole bone structure.

TANGENTIAL SECTION OF THE FEMUR OF THE SAME ANIMAL SHOWING THE CIRCULATION

PL. 2, FIG. 12

The meshes of the circulatory plexus are longer and enclose larger bone areas than those seen in the femur of the turkey. The vascular expansions are not as prominent as they are in some of the other bones, but may be seen here and there. A general plexiform plan of circulation is evident, but an elongation of the meshes in the central portion shows a slight variation in the circulatory distribution.

TANGENTIAL SECTION OF THE FEMUR OF A DOMESTIC CHICKEN, GALLUS

PL. 2, FIG. 13

The type of structure is a first and early third. Several entering canals without surrounding lamellae are present. The circulation appears as a rich plexus of small blood vessels coming off from a central vessel which extends lengthwise of the section. The meshes of the plexus are small, round, oval or irregular in shape and the lacunae of the bone substance are round or oval with short, branching canaliculi.

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TANGENTIAL SECTION OF THE FEMUR OF A PRAIRIE CHICKEN, TYMPANUCHUS AMERICANUS, SHOWING THE CIRCULATION

PL. 2, FIG. 14

The type of bone is first. A few entering vascular canals, without surrounding lamellae, are seen in the bone substance. The circulation is a rich plexus of blood vessels with small, round and irregularly shaped meshes. It is situated nearer the periosteal than the medullary surface. The lacunae of the bone substance are round or oval and have short bushy canaliculi.

TANGENTIAL SECTION OF THE FEMUR OF A DOMESTIC DUCK, ANAS DOMESTICA, SHOWING THE CIRCULATION

PL. 2, FIG. 15

The type of bone is an early second. The section has two rich plexuses of blood vessels, one above the other, with bone substance between them. The meshes are quite regular in form and somewhat larger than those found in the other birds examined. Here and there are seen entering vascular canals without surrounding lamellae. The lacunae of the bone substance are round or oval with short bushy canaliculi.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF A FRUIT BAT, PTEROPUS (CELEBES)

CROSS SECTION SHOWING THE STRUCTURE

PL. 2, FIG. 16

The section is composed of a wide central ring of lamellae perforated in the inner wall by a few vascular canals extending lengthwise of the bone. Internal circumferential lamellae surround the medullary canal and poorly differentiated external lamellae surround the section. The lacunae are oval with straight canaliculi.

TANGENTIAL SECTION OF THE SAME FEMUR SHOWING THE CIRCULATION

PL. 2, FIG. 17

In this section are seen the vascular canals of the inner wall extending from above downward and inward. The canals are parallel with each other and some of them are branched. They were absent in the outer wall.

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CROSS AND TANGENTIAL SECTIONS OF A SECOND TYPE BONE IN MAMMALS AS SEEN IN THE FEMUR OF A LAMB, OVIS

CROSS SECTION SHOWING THE STRUCTURE

PL. 2, FIG. 18

The section is composed of concentric laminae which are more completely differentiated than they are in birds. Here and there the laminae are interrupted by Haversian systems of a late differentiation and the concentric canals between the laminae are widened at intervals and around them are incompletely differentiated lamellae forming an early aberrant type of Haversian system. The posterior ridge is composed of Haversian systems of a late differentiation.

TANGENTIAL SECTION OF THE FEMUR OF THE SAME ANIMAL SHOWING THE CIRCULATION

PL. 2, FIG. 19

The circulatory plan of arrangement in this bone is not precisely like that observed in the second type bone in birds. While it is plexiform in character there is about it more or less irregularity in distribution approaching the branching type of circulation. Near the sides of the drawing the plexus has a long mesh; while in the central portion it has more of a branching character. The vascular expansion seen in the center of the drawing gives the impression of a distributing point in the circulation. A few entering vascular canals are seen.

CROSS AND TANGENTIAL SECTIONS OF ANOTHER SECOND TYPE BONE IN MAMMALS AS SEEN IN THE FEMUR OF THE MEXICAN BURRO

CROSS SECTION SHOWING STRUCTURE

PL. 2, FIG. 20

The section is composed of concentric laminae interrupted by Haversian systems of different degrees of differentiation. The structure is similar to that seen in the femur of the lamb and a large number of other mammals which have the same type bone.

TANGENTIAL SECTION OF THE FEMUR OF THE SAME ANIMAL, SHOWING THE CIRCULATION

PL. 2, FIG. 21

The type is plexiform and the meshes of the plexus are much more regular in shape than those seen in the femur of the lamb. There is no evidence of a branching character. The vascular expansions are not as prominent as they were in the femur of the lamb.

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TANGENTIAL SECTION OF THE FEMUR OF AN ELK, ALCES AMERICANUS, SHOWING THE CIRCULATION

PL. 3, FIG. 22

The type of bone is second. Several perforations in the bone substance for the passage of blood vessels are present. Some of them are surrounded by enclosing lamellae and some are not (Volkmann's canals). The circulation is an extensive plexus of blood vessels with round and irregularly shaped meshes. It has a general direction lengthwise of the bone.

TANGENTIAL SECTION OF THE FEMUR OF A BELGIAN HARE, LEPUS, SHOWING THE CIRCULATION

PL. 3, FIG. 23

The type of bone is an early second and third. Entering vascular canals through which blood vessels are seen to pass and ramify in the bone substance are present in the central portion of the section. The canals are not surrounded by lamellae. The circulation is a combination of a branching and plexiform distribution. The vascular expansions are prominent. One is seen in a vessel shortly after entering the bone. It is a matter of observation in bone circulations that the type of circulation varies with the type of structure.

TANGENTIAL SECTION OF THE FEMUR OF A BULLDOG, SHOWING THE CIRCULATION

PL. 3, FIG. 24

The type of bone is second and third. Entering vascular canals, without enclosing lamellae, are seen in the bone substance through which blood vessels are passing. The circulation is a dense branching and plexiform combination. The vessels are small in diameter, frequently branching, the union of their branches producing a plexiform effect.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF A MONKEY, MACACA RHESUS

CROSS SECTION SHOWING THE STRUCTURE

PL. 3, FIG. 25

The type of bone is first and third. The section is composed of lamellae interrupted by Haversian systems of early and late differentiations. Crescents of late Haversian differentiation are found bordering upon the medullary canal in the anterior inner and posterior outer wall. The lacunae of the bone are long with straight canaliculi. The principal structure is lamellar and the type is much more first than third.

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TANGENTIAL SECTION OF THE SAME FEMUR, SHOWING THE CIRCULATION

PL. 3, FIG. 26

A few entering vascular canals without surrounding lamellae are present. The circulation is a dense branching type which, here and there, presents a slight appearance of the plexiform distribution. The blood vessels are large and trunk-like in places and a very few vascular expansions are present.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF A 9 MONTHS' HUMAN WHITE FETUS

CROSS SECTION SHOWING THE STRUCTURE

PL. 3, FIG. 27

The section is composed of short laminae with central canals widening and shortening until they are transformed into Haversian systems. External circumferential lamellae surround the section (posterior wall excepted) and directly underneath the lamellae is a row of advanced differentiations of Haversian systems. The medullary canal is small, irregular in shape and situated in the anterior half of the section. The posterior wall is composed of Haversian systems of advanced differentiations and in the mid line where the walls of the bone unite is a narrow radiating layer of bone substance which disappears as complete union takes place.

TANGENTIAL SECTION OF THE SAME FEMUR SHOWING THE CIRCULATION

PL. 3, FIG. 28

The circulation is plexiform in type, the general direction of which is longitudinal and slightly oblique. The vessels forming the plexus have short branches which seem to disappear in the bone substance within the meshes. Vascular expansions are present, one being shown in the left central portion of the figure.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF A WHITE CHILD 9 YEARS OLD

CROSS SECTION SHOWING THE STRUCTURE

PL. 3, FIG. 29

The type of bone is first and third. Around the periphery of the section is a wide crescent shaped band of lamellae enclosing numerous vascular canals of the earliest Haversian differentiation, such as were

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observed in the bone of the fish, plate 1, figure 2. Around the medullary canal are the internal circumferential lamellae forming an enclosing ring of irregular widths. Within this ring are also found vascular canals of early Haversian differentiation extending longitudinally. Between the external and internal lamellae above described is a ring of Haversian systems of late differentiation, deficient in the anterior wall and increasing in width in the outer lateral wall as it reaches the posterior ridge. The lacunae are long and narrow with straight canaliculi.

TANGENTIAL SECTION OF THE SAME FEMUR SHOWING THE CIRCULATION

PL. 3, FIG. 30

Entering canals with and without enclosing lamellae are of frequent occurrence. The circulation is a combination of the branching and plexiform types. The central portion is branching and the lateral, plexiform, vascular expansions are not as prominent as they are in many other sections. The section shows the circulatory combination of type conforming to the structural type combination.

CROSS AND TANGENTIAL SECTIONS OF THE FEMUR OF ADULT MAN, A WHITE MALE

CROSS SECTION SHOWING THE STRUCTURE

PL. 4, FIG. 31

The bone is third type in differentiation with the exception of a portion of the anterior wall where the remains of first type bone are found. The section is composed of completely differentiated Haversian systems, some of which are senile. The external circumferential lamellae are fragmentary, while the internal are complete.

TANGENTIAL SECTION OF THE SAME FEMUR, SHOWING THE CIRCULATION

PL. 4, FIG. 32

The type of circulation is plexiform with wide, irregularly shaped meshes. Entering vascular canals surrounded by lamellae are seen here and there in the section. Vascular expansions are prominent. This section is taken from the bone represented in plate 4, figure 31, near the periosteal surface of the left side of the drawing and near the posterior ridge. It is difficult to think of the circulation as shown in plate 4, figure 32, as belonging to that locality.

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TANGENTIAL SECTION OF THE FEMUR OF MAN, A WHITE MALE, SHOWING CIRCULATION

PL. 4, FIG. 33

The type of bone is first and third. Numerous entering vascular canals with and without enclosing lamellae are present. The circulation is a dense branching and plexiform distribution of blood vessels with small meshes of various shapes. Vascular expansions are numerous and large. The lacunae of the bone substance are round, oval, and long and narrow with the canaliculi which belongs to each degree of differentiation. The density of the circulation varies in different bones of the same structural type and also in bones of different type combinations.

TANGENTIAL SECTION OF THE FEMUR OF MAN, A WHITE MALE, SHOWING THE CIRCULATION

PL. 4, FIG. 34

The type of bone is first and third. The type of circulation is branching, changing to plexiform. Entering canals, for the most part without enclosing lamellae, are few in number in this section. The circulation shown in the drawing is situated in the external lamellae which encloses the internal third type differentiation. It is a large branch dividing into many small ones which, by uniting, form a plexiform distribution.

TANGENTIAL SECTION OF THE FEMUR OF MAN, A WHITE MALE, AGE 50, WHO DIED OF PULMONARY TUBERCULOSIS

PL. 4, FIG. 35

The type of bone is third. The type of circulation is essentially branching although a coarsely plexiform arrangement can be distinguished. Entering canals with and without enclosing lamellae are seen in the bone substance. The blood vessels are irregular in size and shape and show varicose enlargements very frequently. Whether or not this varicose condition and irregularity in the circulation in bone are indices of similar changes in the general circulation cannot be told; but they may be thought of in connection with the pathological condition present in this individual.

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THE CIRCULATION IN FLAT BONES

CROSS, LONGITUDINAL, AND TANGENTIAL SECTIONS OF A HUMAN FRONTAL BONE

CROSS SECTION SHOWING THE STRUCTURE

PL. 4, FIG. 36

The bone is composed of outer and inner tables united by a central cancellous diplöe. The two tables are composed of first type bone enclosing a few Haversian systems in cross section and a few short segments of blood vessels. The diplöe is a coarse, cancellous bone with large, small, and irregularly shaped cavities enclosed by first type bone walls. The walls are composed of lamellae in which Haversian systems are seen in cross section. This section was taken from the vertical portion of the frontal bone.

LONGITUDINAL SECTION OF THE SAME FRONTAL BONE, SHOWING THE STRUCTURE

PL. 4, FIG. 37

This section has practically the same structure as the cross section, as may be seen by comparing the drawings. This section is cut at right angles to that seen in plate 4, figure 36. It is taken from the same region, and Haversian systems, in cross section, are found in both situations. The Haversian systems therefore run at right angles to each other, which can hardly be accounted for on mechanical grounds.

TANGENTIAL SECTION OF THE OUTER TABLE OF THE SAME FRONTAL BONE TAKEN FROM THE SAME REGION AS FIGURE 36, PLATE 4, SHOWING THE CIRCULATION

PL. 4, FIG. 38

The section is situated nearer the external surface of the bone than the diplöe. Numerous entering canals with and without enclosing lamellae are found in the bone substance. The circulation is branching in type. The vascular expansions are large and numerous and appear to form physical centers of distribution. The blood vessels are relatively large and frequently branch.

ENTERING VASCULAR CANALS OF THE OUTER TABLE OF THE FRONTAL BONE

PL. 5, FIG. 39

There are two forms, the one at the left in the drawing without enclosing lamellae (Volkmann's canals), and the one at the right with enclosing lamellae. The Volkmann's canals are smaller than

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the others. As soon as the blood vessels pass through the external surface of the bone they send off branches into the planes of their divisions and form the branching distributions there.

TANGENTIAL SECTION OF THE INNER TABLE OF THE SAME FRONTAL BONE, SHOWING THE CIRCULATION

PL. 5, FIG. 40

In this section the bone is perforated by numerous entering canals with and without enclosing lamellae. The blood vessels from the cerebral surface enter the bone by these canals and find their way to the diplöe. The circulation within the bone is branching in type and situated nearer the cerebral surface than the diplöe. Many vascular expansions are present with their incoming and outgoing vessels.

TANGENTIAL SECTION OF THE OUTER TABLE OF A HUMAN PARIETAL BONE, SHOWING THE CIRCULATION

PL. 5, FIG. 41

The section is taken from the central portion of the bone. The type of bone is first. Entering vascular canals surrounded by lamellae are numerous. The circulation is branching in type. Vascular expansions are large and numerous. Those in the center give the impression of distributing points in the circulation.

TANGENTIAL SECTION OF THE INNER TABLE OF THE SAME PARIETAL BONE SHOWING THE CIRCULATION

PL. 5, FIG. 42

The section is situated nearer the cerebral surface than the diplöe. Entering vascular canals with enclosing lamellae are numerous. The circulation is branching in type and not as dense as that of the outer table. The vascular expansions are many and large. The type of bone is first.

TANGENTIAL SECTION OF THE SQUAMOUS PORTION OF THE TEMPORAL BONE OF MAN, SHOWING THE CIRCULATION

PL. 5, FIG. 43

The type of bone is first. Entering canals with and without enclosing lamellae are present. The circulation is branching in type and the vascular expansions are large and very numerous. The expansions vary in size and frequency of occurrence in different sections. In some instances they are very small and few in number, in others, large and numerous, and they are much more prominent in the

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branching than in the plexiform type of circulation. They are especially prominent in this section.

TANGENTIAL SECTION OF THE OUTER TABLE OF A HUMAN OCCIPITAL BONE, SHOWING THE CIRCULATION

PL. 5, FIG. 44

The section is taken a short distance above the foramen magnum. The circulation is a dense branching type situated near the external surface of the bone. There are many vascular expansions from which branching vessels take their departure. Entering canals with and without surrounding lamellae are present in the first type bone substance.

TANGENTIAL SECTION OF THE INNER TABLE OF THE SAME OCCIPITAL BONE, SHOWING THE CIRCULATION

PL. 5, FIG. 45

The type of bone is first. Entering canals with and without surrounding lamellae are numerous. The section is situated near the cerebral surface. The circulation is branching in type and very dense in character. Large branches extend in different directions and from these, small branches are sent off into the bone substance. The vascular expansions are not as numerous as those in the outer table, figure 44.

TWO VASCULAR EXPANSIONS AS THEY WERE SEEN IN THE OUTER TABLE OF THE OCCIPITAL BONE

PL. 5, FIG. 46

The vascular expansions are observed in all branching and in many sections of the plexiform type of circulation. They are nearly always filled with fat globules with dark, wide contours which are so closely faceted together that they completely occupy the expansion cavities. This would, of course, block the circulation if it existed in the living bone. The condition was misleading in significance until it was noticed that the fat globules were found in ground sections and not in thin unground bone plates; so that they are probably produced by the melting heat of friction during the grinding process and fill the expansions. The expansions probably have a physical value as distributing centers in the circulation or they may be for the purpose of establishing and maintaining a circulatory equilibrium in bone.

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TANGENTIAL SECTION OF A HUMAN INFERIOR MAXILLA, SHOWING THE CIRCULATION

PL. 5, FIG. 47

The section is taken from the bone just in front of and below the left central incisor tooth. The type of bone is first. Entering canals with and without lamellae are present. The circulation is a branching plexiform type having a slanting direction from above downward and forward. The meshes are long and irregular in shape. Vascular expansions are numerous.

TANGENTIAL SECTION OF THE INFRA-SPINOUS FOSSA OF A HUMAN SCAPULA, SHOWING THE CIRCULATION

PL. 6, FIG. 48

The type of bone is first with here and there an Haversian system. A few entering canals with enclosing lamellae are seen in the section. The circulation is a branching and plexiform type, the former predominating. Vascular expansions are prominent. The one in the center of the drawing suggests a distributing center.

TANGENTIAL SECTION OF THE SUPRA-SPINOUS FOSSA OF THE SAME SCAPULA, SHOWING THE CIRCULATION

PL. 6, FIG. 49

The type of bone is first. A few entering canals with and without surrounding lamellae are present. The circulation is branching in type with a few vascular expansions. It takes an oblique direction from above downwards and toward the vertebral border.

CROSS AND TANGENTIAL SECTIONS OF THE 9TH RIB OF ADULT MAN, MALE WHITE

CROSS SECTION SHOWING THE STRUCTURE

PL. 6, FIG. 50

This is a third type bone composed of Haversian systems of a late degree of differentiation. The systems extend lengthwise of the rib and enclose a cancellous center.

TANGENTIAL SECTION OF THE INNER WALL OF THE SAME RIB, SHOWING THE CIRCULATION

PL. 6, FIG. 51

The section is taken from the posterior third of the bone. The circulation is an elongated plexus. In the center of the section is a vascular expansion which suggests a center of distribution for the blood vessels.

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DEVELOPMENTAL ADVANCES IN THE CIRCULATION DETERMINE THE STRUCTURAL TYPES OF BONE

It is generally supposed that bone is preeminently mechanical in function on account of its position in the body and its rigid character. It forms the skeleton of the animal body, supports its weight, gives attachment to muscles by means of which locomotion is possible, serves as a framework upon which the viscera are hung, affords protection and gives efficiency to the laboratory of chemical activities constantly in operation during life. It is chiefly for these reasons that we attribute a mechanical function to bone. This thought is further strengthened by the microscopic structure so familiar to us either from personal observation or from text books of histology, in both of which bone is represented, usually, as composed of Haversian systems.

There are however, as shown before, three structural types of bone, the first, second, and third.

The first type is composed of bone substance or lamellae, the second of laminae which are produced by a vascular separation of lamellae into parallel divisions, and the third, of Haversian systems which are produced by arranging lamellae around small central vascular canals called Haversian canals. The Haversian system, therefore, is the most complex and highly organized bone unit. The types of structure follow the advancing changes in the circulation, since the second type bone is not recognizable until the first has been separated into laminae by parallel vascular canals. There are two general types of circulation, the branching and the plexiform, each one giving an individual character to the type of bone it produces. Bone derived from connective tissue membranes retains the branching circulation of those membranes, while bone derived from cartilage has the plexiform circulation.

In going from a branching to a plexiform type of circulation, the type of bone advances from the first to the second or third. The blood supply in a plexiform circulation is greater in volume than it is in a branching circulation, for the reason that there are more blood vessels in a given area in the former than in the latter. This increased blood supply adds an increased physiological value to the bone units of structure and is the foundation of advancement in tissue values: so that blood supply is determined by the extent, plan of distribution, or type of circulation and the type of tissue, physiologically considered, by the blood supply, or in this particular instance, the type of bone is determined by the type of circulation.

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THE STRUCTURAL UNITS OF BONE—FIRST, SECOND, AND THIRD, OR LAMELLAE, LAMINAE, AND HAVERSIAN SYSTEMS—ARE NOT ESSENTIALLY MECHANICAL

If all bones were Haversian system bones, or, if there was any one bone which always has Haversian systems as the predominating structural units, no matter in what individual it was found, we might be convinced that their constant presence was sufficient evidence of a mechanical function. But when we know that there are three bone units of structure and that no one of them is constantly present in bones of different animals as the only unit, and not even in bones of individuals of the same birth,[5] the idea of a purely mechanical function of bone is severely shaken if not abandoned. The three units, the lamella, lamina, and Haversian system, are found in bones of various animals in such great proportional and locational confusion that their mechanical purposes disappear and we are obliged to look further for an explanation of their strange and unexpected occurrences.

Again, if we examine these units from a mechanical viewpoint and then observe their locations in the bones of different animals we will find that they are *not* always found where the same mechanical conditions would require them and are very often found where they could serve no mechanical function of any importance. Lamellae are layers of bone substance, laminae are strata composed of lamellae, and Haversian systems are hollow cylinders composed of a variable number of lamellae enclosing a central canal. Of the three units, therefore, the Haversian systems offer the most mechanical service by construction and are the best adapted to support weight, withstand muscular stress, and serve the general requirements of a skeleton. We would, then, naturally expect to find them constantly present in such long bones as the femur, tibia and fibula of quadrupeds and bipeds and generally absent from the flat bones of the head and face. But in these respects we are disappointed. They are found, as a pure type, in the long bones of only a few mammals and are absent as predominating units in the long bones of a large number of mammals including the three races of man, black, yellow-brown and white.[6] Haversian systems in their later degrees of differentiation are not found at all in amphibians, reptiles, birds, bats, monotremes, marsupials and many of the edentates, although the same mechanical functions are demanded by their vocational habits. In the femur, tibia, fibula, humerus, radius, ulna, clavicle, metacarpal and metatarsal bones of man, they are present as predominating

[5] *Idem.*
[6] *Idem.*

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units in some and occur very infrequently in other individuals. In the flat bones of the cranium and in the irregular bones like those of the pelvis a few are found where it is difficult, if not impossible, to understand how they could perform any mechanical function of any value.

In the human frontal, parietal and occipital bones, a few Haversian systems may be found at right angles to each other; in the squamous portion of the temporal bone they extend vertically; in the hard palate, antero-posteriorly; in the superior and inferior maxillae, horizontally; in the spine of the scapula, horizontally; in the crest of the ilium horizontally; and in the ribs horizontally. In these different situations the mechanical functions of the Haversian systems do not seem to answer any requirement which is common to them all. Furthermore, they are not invariably found in these situations and even may not be present at all. Their presence or absence or situation within the bone is more satisfactorily explained if we assume that developmental advances in the circulation determine the types of bone.

CONCLUSIONS

A study of the circulations as they were observed in the foregoing slides leads one to the following conclusions:

1. That a cross section of bone gives no idea of the plan of circulation.

2. That there are two types of circulation, the branching and the plexiform, and these are seen only in tangential sections.

3. That the plan of circulation in bone derived from connective tissue is branching; derived from cartilage, plexiform.

4. That the circulation in a first type bone is branching, in the second and third, plexiform.

5. That the plexiform is a more advanced type of circulation than the branching and represents a later plan of vascular distribution and a more advanced degree of bone differentiation.

6. That bone is a very vascular organ.

7. That blood vessels are composed of extremely thin and finely striated connective tissue walls, without smooth muscle, occupying canals in the bone substance.

8. That vascular expansions occur in bone circulations and, by their positions, suggest equalizing blood pressures and uniformity in the circulation.

9. That developmental advances in the circulation determine types of bone.

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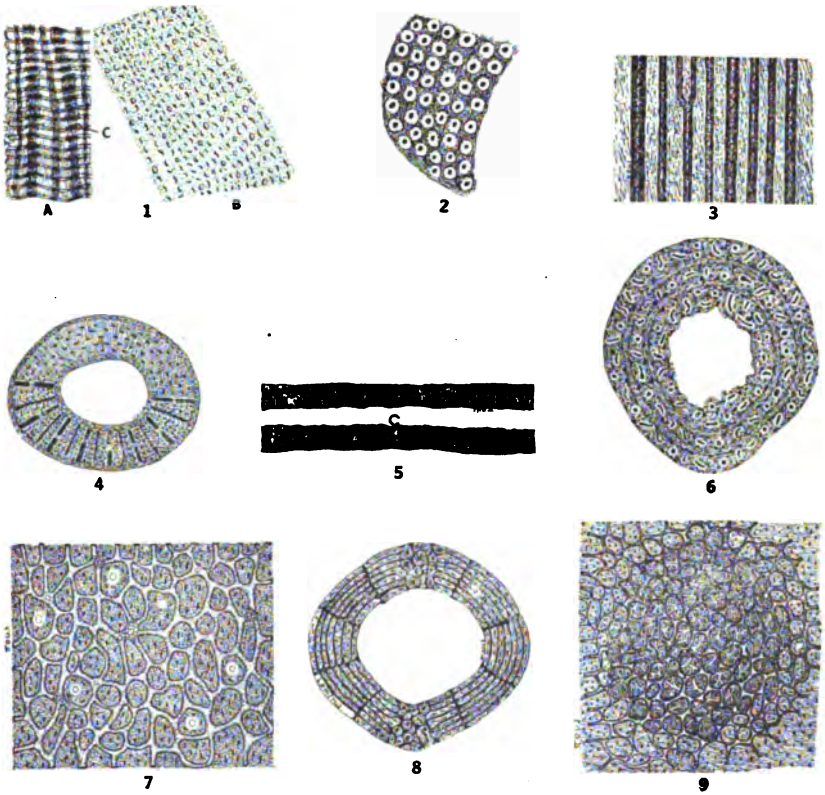

FIG. 1. A. Cross section of the bone substance of the lower jaw of a Mascalonge, Esox, showing vascular channels.

1. B. Tangential section of a cranial bone of the Mascalonge, showing parallel rows of small objects in the bone substance.

2. Cross section of the lower jaw of the Mascalonge, showing the early differentiation of Haversian systems.

3. Tangential section of the inner ridge of the lower jaw of Mascalonge, showing the circulation.

4. Cross section of the femur of a medium sized bullfrog, Rana catesbeiana, showing the structure.

5. Longitudinal section of the femur of a medium sized bullfrog, Rana catesbeiana, showing the looped vascular canals of the inner wall. C, center of the shaft.

6. Cross section of the femur of an alligator, Alligator mississippiensis, showing the structure.

7. Tangential section of the same, showing the circulation.

8. Cross section of the femur of a domestic turkey, Meleagris gallopavo, showing the structure.

9. Tangential section of the same, showing the circulation.

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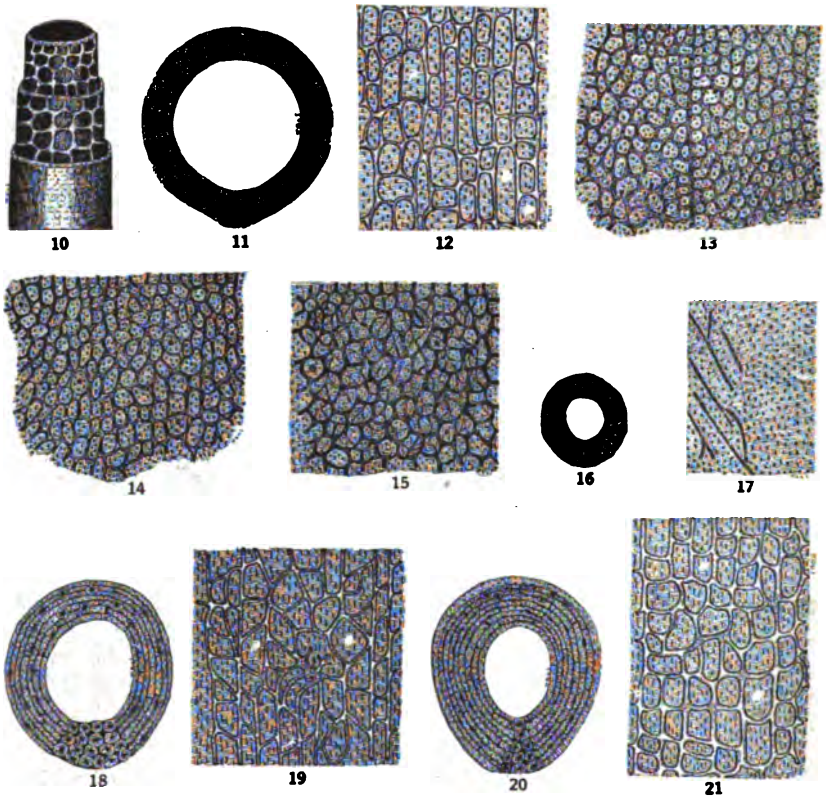

FIG. 10. Reconstruction of a second type bone with its circulation.
11. Cross section of the femur of a turkey buzzard, Cathartes aura septentrionalis, showing the structure.
12. Tangential section of the same, showing the circulation.
13. Tangential section of the femur of a domestic chicken, Gallus, showing the circulation.
14. Tangential section of the femur of a prairie chicken, Tympanuchus americanus, showing the circulation.
15. Tangential section of the femur of a domestic duck, Anas domestica, showing the circulation.
16. Cross section of the femur of a fruit bat, Pteropus (Celebes), showing the structure.
17. Tangential section of the same, showing the circulation.
18. Cross section of the femur of a lamb, Ovis, showing the structure.
19. Tangential section of the same, showing the circulation.
20. Cross section of the femur of a Mexican burro, showing the structure.
21. Tangential section of the same, showing the circulation.

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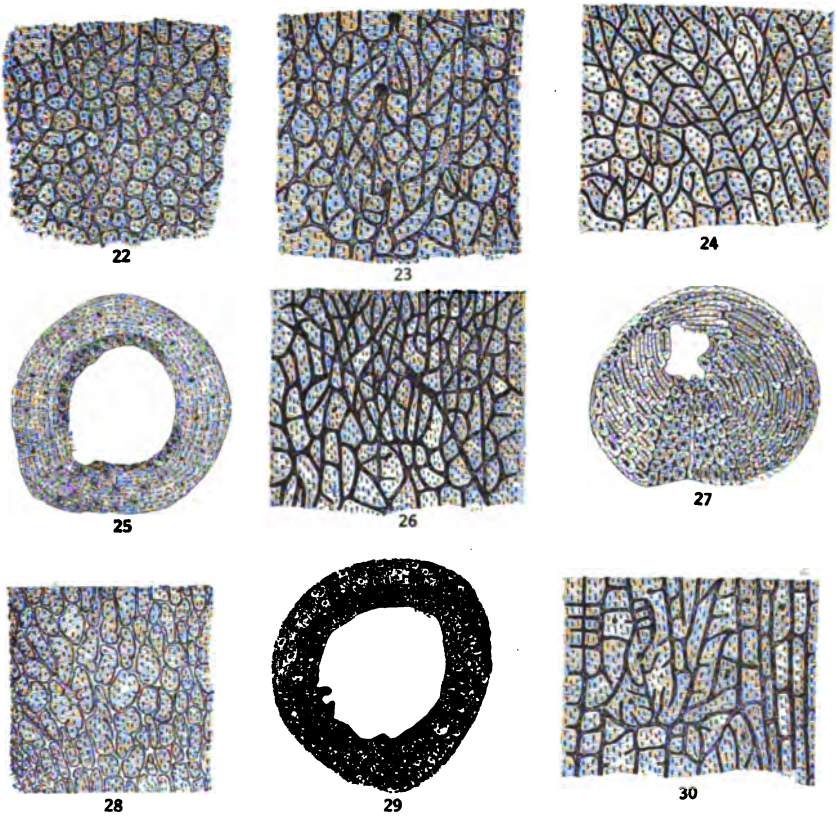

FIG. 22. Tangential section of the femur of an elk, Alces americanus, showing the circulation.
23. Tangential section of the femur of a Belgian hare, Lepus, showing the circulation.
24. Tangential section of the femur of a bulldog, showing the circulation.
25. Cross section of the femur of a monkey, Macaca rhesus, showing the structure.
26. Tangential section of the same, showing the circulation.
27. Cross section of the femur of a 9 months fetus (human), showing the structure.
28. Tangential section of the same, showing the circulation.
29. Cross section of the femur of a white child 9 years old, showing the structure.
30. Tangential section of the same, showing the circulation.

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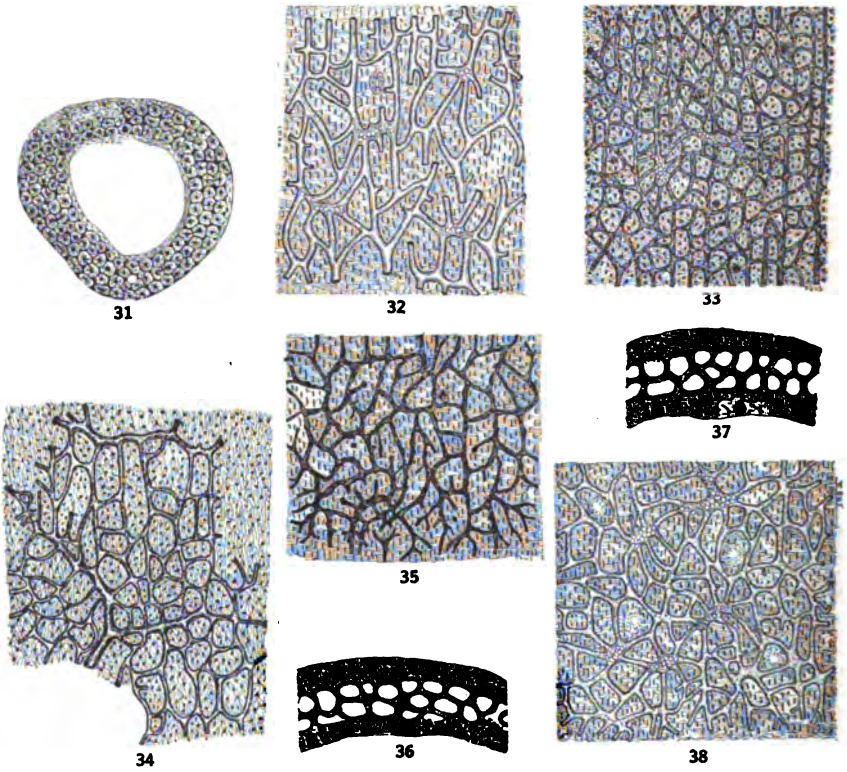

FIG. 31. Cross section of the femur of an adult white male, showing the structure.
32. Tangential section of the same, showing the circulation.
33. Tangential section of the femur of an adult white male, showing the circulation.
34. Tangential section of the femur of an adult white male, showing the circulation.
35. Tangential section of the femur of an adult white male, age 50, who died of pulmonary tuberculosis, showing the circulation.
36. Cross section of a human frontal bone, showing the structure.
37. Longitudinal section of the same, showing the structure.
38. Tangential section of the outer table of the same bone, showing the circulation.

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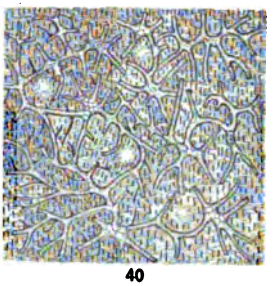
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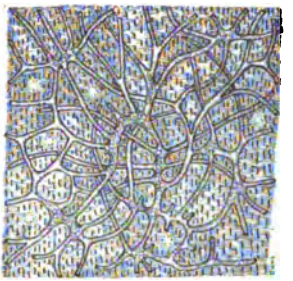
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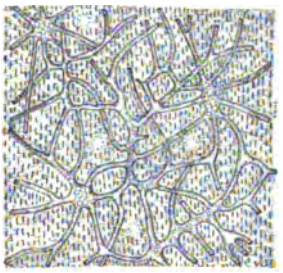
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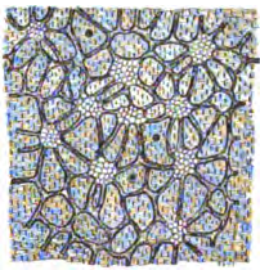
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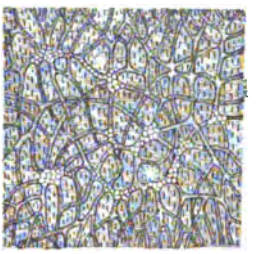
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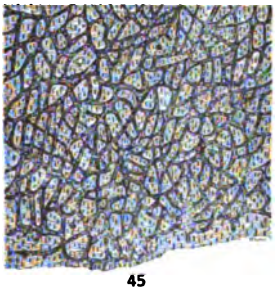
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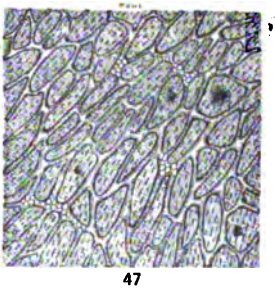
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FIG. 39. Entering vascular canals of outer table of a human frontal bone.
40. Tangential section of the inner table of the same bone, showing the circulation.
41. Tangential section of the outer table of a human parietal bone, showing the circulation.
42. Tangential section of the inner table of the same bone, showing the circulation.
43. Tangential section of the squamous portion of a human temporal bone, showing the circulation.
44. Tangential section of the outer table of a human occipital bone, showing the circulation.
45. Tangential section of the inner table of the same bone, showing the circulation.
46. Vascular expansions filled with fat globules as seen in outer table of occipital bones.
47. Tangential section of human inferior maxilla in front of and just below left central incisor tooth, showing the circulation.

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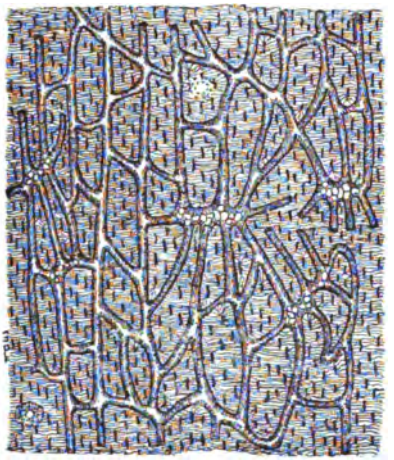

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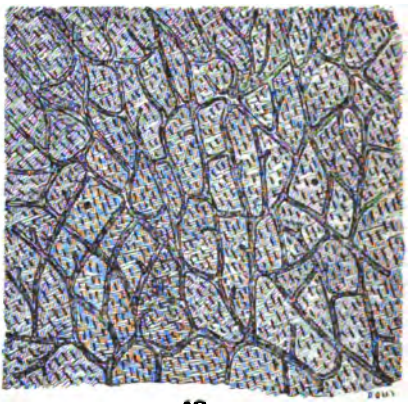

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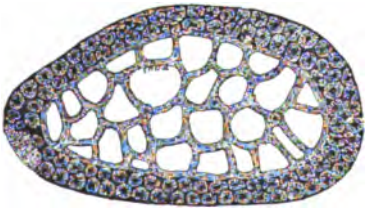

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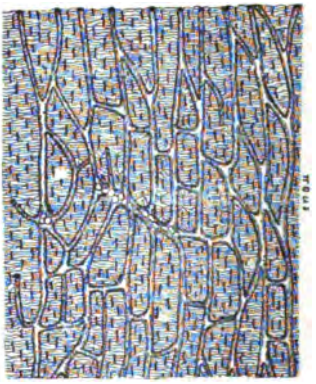

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FIG. 48. Tangential section of the infra-spinous fossa of a human scapula, showing the circulation.

49. Tangential section of the supra-spinous fossa of the same bone, showing the circulation.

50. Cross section of the 9th rib of an adult white male, showing the structure.

51. Tangential section of the same bone, inner wall, showing the circulation.

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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 72, NUMBER 15

EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1921

(PUBLICATION 2669)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
1922

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EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1921

INTRODUCTION

The exploration and field-work conducted by the Smithsonian Institution is one of the means employed for the "increase and diffusion of knowledge," the purpose of the Institution as stipulated in the will of James Smithson, its founder. Attention is directed whenever possible to regions which have previously been imperfectly explored from a scientific point of view, and during the seventy-five years of its existence, the Institution's field parties have been able to make notable additions to existing knowledge as well as to provide vast collections of biological, zoological, and anthropological material for the exhibition and study series of the United States National Museum, a branch of the Institution.

During the past year, the effectiveness of the Institution's limited funds for this work has been so reduced by the prevailing high costs that it was not possible to take part in as many expeditions as is customary. The more important of those which did take the field are briefly described in the present pamphlet, which serves as an announcement of the results obtained, many of the expeditions being later treated more fully in the various series of publications under the direction of the Institution. The photographs here reproduced were for the most part taken by the field-workers themselves.

GEOLOGICAL EXPLORATIONS IN THE CANADIAN ROCKIES

The geological work by Secretary Charles D. Walcott in the Canadian Rockies was in continuation of that of the field seasons of 1919, 1920, for the purpose of securing data on the pre-Devonian strata of the Sawback range in Ranger Brook Canyon, and a reconnaissance of the pre-Devonian formations to the northwest as far as the headwaters of the North Fork of the Saskatchewan River, Alberta.

The season was an unusually cold and stormy one. The party started with a pack train from Banff, June 30, and returned September 30. During this period there were 35 stormy days, 28 cloudy and cold days (20° to 45°) and more or less snow fell on 20 days in August and

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FIG. 2.—Looking south down Baker Creek with upturned Upper Cambrian limestones of the Sawback Range on the left (east); the Ten Peaks in distance across Bow Valley, and Baker Mountain on the right. *Locality*: The camera was on a low ridge directly east of Baker Lake 8.5 miles (13.6 km.) in an air line northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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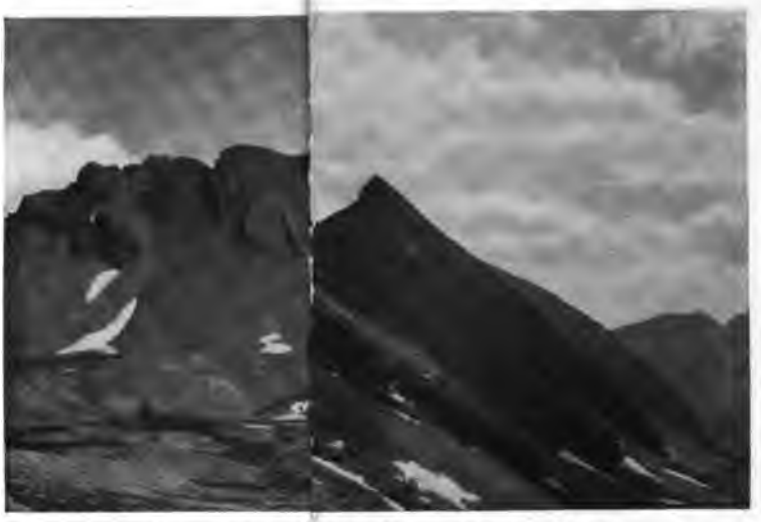

FIG. 3.—Upturn of canyon of Johnson Creek.
Locality: Southeast side (in air line east of Lake Louise Station

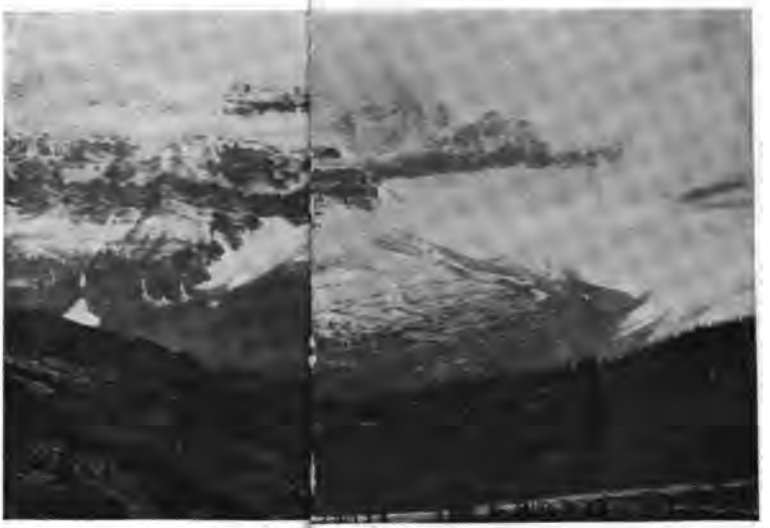

FIG. 4.—Thor yce (11,000') and glaciers.
Locality: Thomps anada. (C. D. Walcott, 1921.)

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FIG. 5.—Mt. Douglass (11,015') from the north, with Black Douglass on the left and White Douglass on the right. Devonian limestones form upper cliffs, with Ordovician and Cambrian limestones on lower eastern slopes. *Locality:* View taken from the north side of the head of Red Deer River about 10.5 miles (16.8 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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FIG. 6.—Thrust fault on north end of Oyster Mountain along which a thick bed of Upper Cambrian limestone has been forced from the southwest (right hand) against a mass of thin bedded and shaly limestones of Devonian or Ordovician age so as to crumple and distort the latter.

Locality: View taken from the north side of the head of Red Deer River about 10.5 miles (16.8 km.) northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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FIG. 7.—Panoramic view looking west over Baker Lake. On the left Baker Mountain (7,230′) and on right Fossil Mountain (9,655′). Back of Fossil Mountain, Ptarmigan Peak (10,060′) and across from it (left) Fort Mountain (9,510′). *Locality:* The camera was on a low ridge directly east of Baker Lake 8.5 miles (13.6 km.) in an air line northeast of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (C. D. Walcott, 1921.)

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September. While on the trail 30 camps were made, but owing to weather conditions and to the fact that the snow remained on the slopes and cliffs above timber line, a relatively small amount of productive work was accomplished.

The section studied near the head of Ranger Brook Canyon of the Sawback Range about 12 miles (19.3 km.) northwest of Banff, was from the base of the Devonian limestones down through the post-Cambrian (Ozarkian) Mons formation and the subjacent Lyell and Sullivan [1] formations of the Upper Cambrian.

FIG. 8.—Camp on the lower eastern slope of Fossil Mountain looking north toward the head of Red Deer River.

The character of the formations is indicated by figures 2 and 3, which show the southwesterly slope of the highly inclined beds (45° to 70°) and the saw-tooth-like effect caused by the unequal rate of erosion of the massive bands of limestone and the softer, more friable sandy and clay shales. Towards the northwest end of the Sawback range at the Red Deer River the Black and White Douglass mountains stand high above the surrounding ridges. (Fig. 5.) Oyster Mountain

[1] See Exploration pamphlet for 1919, Smithsonian Misc. Coll., Vol. 72, No. 1, 1920, p. 15.

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FIG. 9.—Looking north from below Baker Lake to the headwaters of Red Deer River. Mrs. Walcott is pointing to an eagle soaring high above the valley.

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(fig. 6) has been cut out by erosion from the limestones between Douglass and Fossil mountains, and figure 6 illustrates the crumpling of shaly limestones by thrusting of a series of massive limestone strata against them during the period of displacement of the great series of formations of this part of the Cordilleran ranges.

Fossil Mountain, named from the presence of Devonian corals, is about 9 miles (14.4 km.) northeast of Lake Louise Station and faces Baker Creek Pass on the east. It has a good section of Devonian and

FIG. 10.—Wild flower camp on northwest side of Johnson Creek Pass. (Mrs. Mary V. Walcott, 1921.)

pre-Devonian rocks on its eastern slope. There is a fine outlook from camp at the east foot of the mountain.

The broad U-shaped valley (fig. 9) between Fossil and Oyster mountains has been eroded in the shale and thin bedded limestones that pass beneath Fossil Mountain; this formation is one of those in the Sawback Range that is readily worn away, with the result that the agencies of erosion followed by the glaciers have made a valley altogether disproportionate to the present erosion agencies, water, frost and snow.

At a camp in the heart of the Sawback Range on a tributary of Baker Creek leading up to Johnson Pass there was a wonderful

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exhibit of wild flowers in bloom. Mrs. Walcott counted 82 species within a short distance of the tents. A spring-fed pond supplied camp water; dead pines and spruce, firewood; and a grass covered snow-slide slope, abundant feed for the horses.

The moss pink (fig. 11) and the beautiful *Dryas octopetala* were very abundant, but heavy frosts in August killed nearly all the plants and few of the flowers went to seed.

On our way north we crossed over Pipestone Pass and down the Siffleur River. Clearwater River heads in glacial gravels on the east side of the Siffleur about two miles north of Pipestone Pass. Figure 13 is a view looking west through the Clearwater Pass and across to the high cliffs on the western side of Siffleur Canyon.

Twenty-five miles further to the northwest at the point where the south branch (Mistaya Creek), the middle branch (Howse River), and the north branch unite to form the Saskatchewan River, there are some beautiful and instructive views of the surrounding mountains. Figure 1 (frontispiece) is a fine view of the head of the river, with Howse River in the left background and the North Fork beyond the island on the right. The Mount Forbes massif on the left is a superb mountain mass and in the distant center is Division Mountain at the head of Glacier Lake Canyon which we visited in 1919; on the right Survey Peak and beyond two unnamed points. The Glacier Lake section of the pre-Devonian and Upper Cambrian formations was studied on the northern slopes of the Mount Forbes massif as illustrated by figure 1 (frontispiece) of the Smithsonian exploration pamphlet for 1919,[1] and the rugged cliffs and peak of Mount Forbes are shown by text figure 14 of the present number.

Twelve miles northeast of Mount Forbes the cliffs of Mount Murchison (fig. 15) rise high above the dark forested slopes and present a view of the Devonian and pre-Devonian formations that is unequalled in all this region of peaks, cliffs and broad canyon valleys.

Opposite Mount Murchison on the north side of the Saskatchewan, Mount Wilson (fig. 16) presents another section of the pre-Devonian formations, the upper end of which is a massive white quartzite formed of the sands of the beaches over which the Devonian Sea deposited thick layers of calcareous sediments abounding in the remains of corals and various invertebrates of the time. On the west, Mount Wilson rises directly above the North Fork of the Saskatchewan which here flows through a narrow picturesque inner canyon (fig. 17).

[1] Smithsonian Misc. Coll., Vol. 72, No. 1.

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FIG. 11.—Moss pink in Johnson Creek Pass.

FIG. 12.—*Dryas octopetala* below Johnson Creek Pass.

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FIG. 13.—Looking westward up through the head of Clearwater River Canyon across Siffleur River Canyon to the high cliffs of Middle Cambrian rocks, which are about 2 miles (3.2 km.) north of Pipestone Pass. *Locality:* The divide at the head of Clearwater River Canyon is about 21 miles (33.6 km.) in an air line north 12° west of the Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (C. D. Walcott, 1920.)

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FIG. 14.—Mount Forbes as seen from the north, looking across the lower end of Glacier Lake Canyon Valley. The locality is from the upper slope of Survey Peak above Glacier Lake, about 48 miles (76.8 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1919.)

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FIG. 15.—Mount Murchison (11,500') from the north side of the Saskatchewan River.
Locality: The view is from a point about 47 miles (75.2 km.) northwest from Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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FIG. 16.—Mount Wilson from the south. The summit cliffs on the right are formed of the Mount Wilson quartzite capped by dark Devonian limestone.

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FIG. 17.—Falls of the North Fork of the Saskatchewan River about one mile (1.6 km.) above where the North Fork unites with the Middle Fork (Howse River). The rocks are Upper Cambrian shaly limestones dipping east toward Mount Wilson.
Locality. About 48.5 miles (78 km.) northwest from Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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FIG. 18.—Quartzite cliffs at the summit of the north ridge of Mount Wilson. The cliffs are capped by dark Devonian limestones very much as are those of the southeast side of the mountain, as shown by fig. 16.
Locality: View taken from the river flats of the North Fork about 7 miles (11.2 km.) north of the Saskatchewan River and 55 miles (88.4 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada.

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The trail up the North Fork follows the bed of the river most of the way to its head beneath Wilcox Pass. The same is true of the trail up the west branch called Alexandra River, and its northwest extension named Castleguard River, by the Interprovincial survey of the boundary between Alberta and British Columbia. Near the union of Castleguard and Alexandra Rivers there is a fine view of the peaks along the Continental Divide and Alexandra glacier. On one of the

FIG. 19.—Mount Wilson and glacier from the southeast, with the eastern section of the broad syncline, of which Mount Wilson is the western section, on the right.

Locality: View taken from south shore of Saskatchewan River about two miles (3.2 km.) east of Mistaya Creek and 47 miles (75.2 km.) northwest from Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mrs. Mary V. Walcott, 1921.)

misting days of early September a photograph of Alexandra glacier, Queens Peak, and Mount Alexandra was taken from the river bed and is reproduced as figure 20.

Castleguard River heads in a deep, rather broad canyon at the foot of the Castleguard glacier. Thompson Pass is on the southwest and high barrier ridges on the northeast. On the summit of the latter great terraced buttes occur with narrow side facing the line of drainage (fig. 21). These outlying buttes are formed of the alternating hard

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FIG. 20.—View of Alexandra glacier with Mount Alexandra (11,215′) in distance on the north (right), Queens Peak (10,990′) immediately to right of glacier, Mount Douai (10,230′) on left of glacier; all on Continental Divide. The gravelly bed of the flood plain of Alexandra River in the foreground.

Locality: Near head of Alexandra River, a tributary of the North Fork of the Saskatchewan River. Mount Alexandra is about 59 miles (94.8 km.) in an air line northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (Mr. and Mrs. C. D. Walcott, 1921.)

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FIG. 21.—Terraced buttes back from the northeastern branch of the Castleguard River. They all have one or more small glaciers on their lower slopes, which are at about 8,000 feet (2,438 m.) elevation.

Locality: Near head of Castleguard River, 5 miles (8.04 km.) northeast of Thompson Pass, which is about 63 miles (101.3 km.) northwest of Lake Louise Station on the Canadian Pacific Railway, Alberta, Canada. (C. D. Walcott, 1921.)

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FIG. 22.—Waiting for the pack horses to be brought up to receive camera boxes, dunnage bags, blanket rolls, tent, and small impedimenta.

FIG. 23.—Horses foraging through the snow.

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and soft bands of limestone and shale of the Sullivan [1] formation, and they form a somewhat unique topographic feature, and are the top of the world at this point.

Thompson Pass is one of the scenic features of the Continental Divide when viewed from the high Alpine valley on the northeast side of Castleguard Canyon. The Pass is low (6,511′ or 1,984 m.), and bold high ridges lead up to mountain summits on either side (fig. 4). A view taken on a misting day shows Watchman Lake (6,050′ or

FIG. 24.—A snowy morning on upper Pipestone River.

1,844 m.) and above it Cinema Lake (6,400′ or 1,950 m.) on the northeast slope of the Pass. On the south Watchman Peak (8,674′ or 2.634 m.) which lies in front of Mount Rice (10,745′ or 3,275 m.) and on the right Mount Bryce (11,000′ or 3,352 m.) and Bryce glacier, which is at the head of the middle branch of Castleguard River. The Castleguard glaciers flow down from Mount Castleguard (10,090′ or 3,075 m.), which is a fine peak a few miles northeast of Mount Bryce. Figure 4 is a fine illustration of a misting day along the Continental Divide. We were camped for a week on the south side of the Alpine

[1] Smithsonian Misc. Coll., Vol. 72, No. 1, 1920, p. 15.

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upland in the foreground, and on each day numerous squalls of fine snow or frozen mist would sweep over from Thompson Pass or Bryce glacier.

I do not know the origin of the names of Rice and Bryce, but it is probable that the mountains were named in honor of Sir Cecil Arthur Spring-Rice and Lord James Bryce.

As the result of unfavorable weather not more than one-third of the work planned was completed when the late September snow drove us back to the railroad. The morning we broke camp to go to Lake Louise Station the horses were pawing away the snow to get at the grass beneath (fig. 23), and the snow was very beautiful on the trees and along the stream below camp (fig. 24). The trail was obscured by it and to make matters more complicated, snow driven by a strong east wind beat into our faces during the seven hours march. The next day the sun came out and the storms were forgotten except for the wonderful snow scenes along the trail down the Pipestone River.

The Commissioner of the Canadian National Parks, Hon. J. B. Harkin, and the members of the Parks Service in the field, from Superintendent to Park Warden, were most helpful, and the same is true of the officials and employees of the Canadian Pacific Railway.

PALEONTOLOGICAL FIELD-WORK IN THE UNITED STATES

Field-work by the Department of Geology of the U. S. National Museum during 1921 was carried on by three members of the Division of Invertebrate and Vertebrate Paleontology.

Dr. R. S. Bassler, Curator of the Division of Paleontology, in cooperation with the Geological Survey of Tennessee spent the month of July in field-work in the Central Basin of that State, where he was occupied in collecting geologic material and in mapping and studying the economic resources of the Franklin quadrangle in Williamson County, south of Nashville. This area of about 250 square miles is of economic interest, on account of phosphate and oil shale possibilities. It is also classic ground for the paleontologist because of the numerous outcrops of Ordovician and later Paleozoic formations which afford a wealth of fossils. During the course of the mapping, Dr. Bassler was able to collect a considerable number of these fossils needed in the museum study series and was also fortunate in securing several large exhibits illustrating various geological phenomena. Among the latter is a large mass of limestone composed entirely of the dismembered calices and columns of a large species of crinoid or sea lily in which the individual fragments are perfectly

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FIG. 25.—Contorted and cross bedded phosphate rock, Franklin, Tenn. (Photograph by Bassler.)

FIG. 26.—Massive limestone with an intercalated coral reef, near Franklin, Tenn. (Photograph by Bassler.)

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preserved and admirably illustrate the formation of a limestone through the accumulation of this type of animal remains. Material was also secured, both for the exhibition and study series, illustrating the origin of the phosphate beds of the locality through the removal from a phosphatic limestone of the easily soluble calcium carbonate by the leaching power of surface waters. Such material is represented in figure 25 showing a rock outcrop where a porous limestone is overlaid by the contorted and crossbedded rock which upon such leaching gives rise to the phosphate.

Among the interesting stratigraphic results secured was one showing the efficacy of coral reefs of the Ordovician in rock formation. The massive limestone about fifteen feet thick shown in figure 26 represents a middle Ordovician formation here containing but a single reef but within a distance of ten miles the number of intercalated coral reefs has so increased that the formation attains a thickness of over 250 feet.

An ancient Indian village near Brentwood, Tennessee, was visited during this trip in the interest of the Bureau of Ethnology. The object of the visit, namely the determination of the length of time since the village was deserted, proved to be, however, outside of the domain of geology.

Upon the completion of this work Dr. Bassler proceeded to Springfield, Illinois, where with the permission of Dr. A. R. Crook, Chief of the Museum, he prepared casts of the type specimens of invertebrate fossils contained in the Illinois State Museum collections. The aim in this work is to make the national collections of invertebrate fossils as complete as possible in its representation of type specimens, a work which was further advanced in the early part of January by a visit to the Walker Museum of the University of Chicago, where the casting of all the Paleozoic species which had remained unfinished on the occasion of a former trip was completed.

Through the courtesy of Mr. E. J. Armstrong, of Erie, Pennsylvania, Dr. Bassler was enabled to visit all the classical Silurian and Devonian localities in northwestern Pennsylvania and western New York during the latter half of September. The object of this trip was to obtain a field knowledge of the detailed geology and to collect carefully selected sets of fossils illustrating the numerous formations of this region. This work was successful and the many large collections of Devonian fossils in the museum hitherto lacking exact stratigraphic data can now be determined and arranged in the detail necessary to-day.

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In April, Mr. C. W. Gilmore, the Associate Curator of Vertebrate Paleontology was authorized to undertake a trip into New Mexico, "for the purpose of making collections of geological material for the National Museum and determining the advisability of preserving certain lands in northern New Mexico for national monumental purposes." Mr. Gilmore was obliged to report that:

> Since the many square miles of "bad lands" surrounding the reserved area are equally fossiliferous and in places present much more favorable territory for the recovery of fossil remains than any observed within the boundaries of the monument, and also since the greater part of these surrounding areas lie within Pueblo Grants over which federal control has been relinquished, there would be no advantage in retaining governmental control of so small a part of the area as is represented in the proposed monument.

Mr. Gilmore did, however, find a contiguous fossiliferous area in the Santa Clara Pueblo Grant and secured for the museum a well-preserved skull and other bones of a small rhinoceros, and in an adjoining Pojoaque Pueblo area remains of an extinct camel. The most promising area for collecting would appear to lie within land grants over which the government has at present no control.

In January, this same year, Mr. J. W. Gidley, Assistant Curator in this Division, was authorized in cooperation with the United States Geological Survey to conduct field explorations in the San Pedro and Sulphur Springs Valleys of southern Arizona and on the completion of this work to visit the La Brea asphalt deposits of southern California and from there go to Agate, in Nebraska, for the purpose of securing other exhibition material. The work in Arizona was eminently successful, Mr. Gidley shipping some 24 boxes having an aggregate weight of 5,000 pounds. The bulk of this collection, he reports represents "a practically new Pliocene fauna containing about 60 vertebrate species, most of which are mammalian."

In detail Mr. Gidley reports essentially as follows:

"The geological structure of the San Pedro Valley will be published in detail by Doctor Bryan of the United States Geological Survey. It, however, may be noted here that this beautiful desert valley, now drained by the Rio San Pedro (which, rising near the Mexican border, runs nearly north-northwest, emptying into the Gila River, more than a hundred miles away), narrows and deepens as it runs northward from Benson leaving relatively small and scattered areas of sedimentary deposits which may contain fossil vertebrate remains. Most of our work, therefore, was confined to the upper valley, which forms a rather wide basin bounded on the east by the Dragoon mountains, on the west by the Whetstone Range, and on the south by the Tomb-

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stone mountains, and extends northward a few miles below the town of Benson.

" Erosional exposures in this general region are quite extensive, but time and funds being limited the work done on this expedition was confined entirely to two promising localities of relatively small area, previously located by Doctor Bryan. One of these is situated on the west side of the valley, about two or three miles due south of

FIG. 27.—General view of fossil bearing exposure at Curtis Ranch locality, looking across the San Pedro Valley. Partly excavated bones of Glyptodon in foreground. (Photograph by Gidley.)

Benson, the other on the east side, at the head of a large 'wash' three miles east of the Curtis ranch which is situated on the state road about 14 miles south-southeast of Benson and an equal distance northwest of Tombstone. The latter locality occupied the greater part of my time and yielded by far the greater amount of material, although the number of species later collected in the Benson locality, slightly exceeded those found here.

" Among the larger, and, from the museum standpoint, more important specimens secured at this locality are included parts of two skeletons of a new species of mastodon, and parts of three skeletons of a large armored edentate, *Glyptotherium,* which when restored should make a striking exhibition piece.

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"Other material obtained here consists of remains representing a wide variety of species which include a large and a smaller species of camel, the latter apparently closely related to the South American guanaco; two or three species of horses, a species of deer; a small extinct antelope of the *Merycodus* type; a carnivore related to the dog-wolf group but more primitive in some respects than any of the living forms; several new species of the rodent group, but all belong-

FIG. 28.—Portion of the carapace or bony skin covering of a Glyptodon, partially excavated. Curtis Ranch locality. (Photograph by Gidley.)

ing to modern genera; two species of land turtles, and a species of bird not yet determined.

"At the close of this work, which had nearly exhausted the original allotment for field expenses, an additional sum was granted, whereby it was possible to proceed with a desired investigation planned for earlier, in the Sulphur Springs Valley near Willcox.

"I arrived at Willcox on the 15th of March. As found on a previous visit the conditions were not such as would inspire enthusiasm over the prospects of a good collecting-field. The surrounding country stretched away for miles in every direction almost as level as a floor, with no erosional exposures; and had not recent fossil remains already

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been discovered through the digging of a shallow well in the vicinity no one would have suspected their presence here. Several years earlier fossil bones had also been found at nearly the same depth (about 9 feet) in another well, now filled in, which had been dug at a distance of about 250 feet from the present open one. It was thus assumed that the fossil-bearing gravel deposit was of rather wide extent, and that by making a long stripping with plow and scrapers, a considerable area of "pay gravel" might be uncovered and worked at comparatively small expense. The spot chosen as being most promising was naturally that between the two wells.

"At Willcox, the services were procured of a reliable man with teams, plow and scrapers and this work was put into execution. Thanks are here due Mr. Harris, a local real estate agent, who lent valuable aid in this connection. I was also indebted to this gentleman for permission to put through the project, for the locality worked was on deeded land which he had in charge.

"As the stripping progressed, it became evident that the strata, or layers, of deposits passed through did not conform to the section exposed in the abandoned well. Hence, on reaching the 7-foot level three prospect holes, about 15 feet apart, were put down to a depth of about 6 feet, or 4 feet lower than the top of the gravel deposit in the well. In none of these holes was there any sand or gravel encountered thus proving that the gravel exposed in the well was part of an ancient stream channel of limited lateral extent. This discovery of course caused a complete abandonment of the trench excavation work, and the remainder of our time was spent in 'mining' the gravel from the sides of the well as far as was considered safe to do so. In this way several good fossil horse teeth were procured.

"From Willcox, I went by way of Tucson to Feldman, arriving there about noon of the 29th of March, where I was joined by Dr. Bryan. Feldman is a ranch and post office in the lower valley of the San Pedro, about 90 miles north-northwest of Benson and about 10 miles above the junction of the San Pedro with the Gila. The valley here is very much narrowed and deepened, the river bed being nearly 2,000 feet lower than at the Curtis ranch. The gradient of the streams and 'washes' emptying into the San Pedro in this vicinity is very steep and benches and divides rise quite abruptly on either side. Erosional exposures one might expect to find here under these conditions are very much reduced by a heavy covering of gravel of relatively recent age. But paleontological evidence for confirming the age of this part of the valley was so much desired, a special effort

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FIG. 29.—Base of skull of mastodon with tusks in position, partially excavated. Curtis Ranch locality. (Photograph by Gidley.)

FIG. 30.—Searching for small mammal jaws in excavation made in collecting one of the mastodon skeletons. Curtis Ranch locality. (Photograph by Gidley.)

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to procure it was considered worth while. However, the few days spent here met with little success, and owing to the great inconvenience of continuing it further without more complete field equipment, the project was abandoned. On the morning of April 2, we left Feldman, returning to Benson via Tucson, and the next morning began a systematic search for fossils at a locality about two to three miles south of the town. During our earlier stay at the Curtis ranch we had made one short visit to this locality, the material obtained then suggesting a slight difference in age, or phase, between these deposits and those of the Curtis locality. The material obtained at this place is fragmentary and abounds mostly in remains of mammals of small size, intermixed with which were bones of birds of several species sufficiently well preserved for their determination, and a new species of box turtle. Here remains of thirty-four species of vertebrates were recovered. This collection, together with the material obtained at the Curtis ranch locality, in which 26 species are represented, makes up a very considerable fauna which should not only do much toward definitely determining the age of the beds of the San Pedro Valley, but will also throw valuable added light on the at present very little-known animal life of the upper Pliocene of America."

From Arizona, Mr. Gidley proceeded to Los Angeles, California, where he passed a week studying the museum of the southern branch of the University of California and in examining the well-known asphalt bone deposits of the Rancho la Brea. From Los Angeles, he proceeded on the 16th of April to Agate, Nebraska, prepared to carry out a second detail of field-work mentioned above. He was unfortunate here in encountering bad weather, but succeeded in securing for the museum a block of the bone-bearing sandstone some $3\frac{1}{2}$ by $5\frac{1}{2}$ feet and 14 inches in thickness. This was shipped to the museum and preparation for exhibition is now under way.

ASTROPHYSICAL FIELD-WORK IN ARIZONA AND IN CHILE

As stated in last year's Exploration pamphlet,[1] the solar radiation work of the Smithsonian Astrophysical Observatory was removed from Mount Wilson, California, to Mount Harqua Hala, Arizona, in September, 1920, in order to observe under better sky conditions, and in a more favorable place for continuing the observing the whole year round. Under the charge of Dr. C. G. Abbot the work was

[1] Smithsonian Misc. Coll., Vol. 72, No. 6.

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established and continued at Mount Harqua Hala until January 20, 1921, when it was taken in charge by Mr. L. B. Aldrich. He remained until May 20, 1921, when he was relieved by Mr. A. F. Moore, formerly director of the Smithsonian private observing station at Calama and Montezuma, Chile. Under Mr. Moore's charge, the work has been continued steadily at Mount Harqua Hala, with the assistance of Mr. F. A. Greeley.

The Smithsonian Institution maintains from the income of the Hodgkins fund a similar station at Mount Montezuma, near Calama, Chile, under the direction of Mr. L. H. Abbot assisted by Mr. P. E. Greeley. From this Chilean station daily telegrams are forwarded to Buenos Aires, Argentina, giving the observed value of the solar constant of radiation for the day. These data are employed regularly by the Argentine Weather Bureau for weather-forecasting purposes.

While the Smithsonian Institution is not yet in position to champion the use of statistics of solar variation for meteorological forecasts, the great interest which its studies of solar variability have aroused here and abroad seems clearly to warrant the continued maintenance of the Arizona and Chile solar stations under the best possible observing conditions for several years, until a satisfactory basis for a test of the solar variability as a weather-forecasting element has been laid.

The present year has unluckily proved unfortunate at both stations. At Mount Harqua Hala the spring months were very hazy, the summer and autumn months unusually cloudy, with almost unprecedentedly heavy rainfall. At Montezuma the cloudiness of the earlier months was quite unprecedented. During August and September a disarrangement of the apparatus caused apparently by earthquake, combined with illness of the director, led to the loss of many observing days.

In October, Dr. Abbot began an inspection trip to Montezuma, arriving at the station on November 15, and remaining until December 14. During this interval of 30 days, the observers fortunately were able to determine the solar radiation on 26 days, and generally with three or four closely agreeing determinations per day. All of the apparatus was readjusted and improved to the most perfect state of fitness. Many of the results in these conditions proved of a higher grade than ever before observed. In fact it would be hard to conceive of anything which could add now to the excellence of the Montezuma station and outfit.

The accompanying illustrations show the desolate, rainless character of the region; figure 31 shows the mountain top with the observ-

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FIG. 31.—Summit of Mount Montezuma. Observing cave near the top.

FIG. 32.—Garage, Shop and Dwelling, Mount Montezuma.

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ing cave; figure 32, the group of buildings comprising the observer's quarters, the shop and the garage; and figure 33 the entrance to the observing cave with such observing apparatus as is employed outside during observations of the solar constant.

It is possible to drive the automobile on high gear clear to the observer's quarters which are situated at the head of a cañon sheltered on the west by a rise of several hundred feet from the strong west winds of afternoon. There is almost invariably practically complete

FIG. 33.—Pyranometer, coelostat, pyrheliometers and theodolite with L. H. Abbot, Director at Mount Montezuma.

absence of wind for several hours after sunrise, a thing highly favorable to morning work.

The observing cave near the top of the mountain is less than 10 minutes walk from the observer's quarters. It is only necessary to go up twice a day, once to observe, and again at 8.30 P. M. to signal the observed value to Calama, whence it is telegraphed to Buenos Aires.

BOTANICAL EXPEDITION TO THE ORIENT

During the summer and fall, 1921, Dr. A. S. Hitchcock, systematic agrostologist of the Department of Agriculture and custodian of the section of grasses of the Division of Plants in the U. S. National

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Museum, visited the Orient for the purpose of collecting and studying the grasses, especially the bamboos. He left Washington April 25 and returned December 23, visiting the Philippines, Japan, China, and Indo China. Six days were spent at Honolulu on the way over. Collections were made at the following places: *Philippines,* Manila, Los Baños, Baguio; *Japan,* Keelung (Formosa), Yokohama, Tokio, Nikko, Lake Hakone, Mount Fuji, Kyoto, Nagasaki; *China,* Shang-

FIG. 34.—A peasant's hut near Gotemba, Japan. The roofs of the building are thatched with coarse grass. The bundles are for firewood.

hai, Nanking, Kuling, Hongkong, Canton, Wampoa, Yingtak, Shiuchow, Lohfau Mountain, Macao, Island of Hainan, Pakhoi; *Indo-China,* Haiphong, Hanoi, Vinh, Hue, Tourane.

The countries were visited in the order named so that collections might be made at the most favorable season for grasses.

Collecting in the vicinity of Manila is not very satisfactory as the native flora has been largely replaced by introduced species. From Los Baños, the seat of the Agricultural College, a trip was made to the summit of Mount Makeling about 3,500 feet high. This mountain is of especial interest to botanists as it is the most accessible region for the virgin forest, most of which has disappeared from the vicinity of Manila. On this mountain was met one of the worst pests of the eastern tropics, the leeches. At upper altitudes in the rain

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forest these vile worms are found in countless numbers. They attach themselves to the skin and suck the blood with great avidity and constant vigilance is necessary to prevent serious damage.

Japan is not very favorable for the collecting of grasses as it is mostly a forested region and there is comparatively little open country. The bamboos were of interest as there are many species. In the Lake Hakone region the hills were covered for miles with a single

FIG. 35.—Hills near Lake Hakone, Japan. The vegetation on the distant slopes is almost exclusively a single species of bamboo (*Arundinaria chino*), 4 to 8 feet high.

species of bamboo (*Arundinaria chino*), 4 to 8 feet high, often to the exclusion of everything else.

China on the other hand was very rich in grasses. One of the surprises of the trip was to find so much open grass land in a country that is said to be very thickly populated. The cities of China are very much crowded and the valley lands are intensively cultivated, but the hills are unoccupied and almost unused. This is in striking contrast to our own western regions where, except in National Forests and other protected areas, the grass lands are extensively grazed. The basic reason for this condition in China appears to be the risk from bandits. The valley lands can be protected but the hills are open to the attack of robbers.

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China was entered at Shanghai, a large comparatively modern city, much under the influence of foreigners. Here is the only American post office outside of the United States or its possessions. Mail can be sent from here under frank or with United States postage stamps. The two other places visited in central China were Nanking and Kuling. At the former city is the University of Nanking, a flourishing missionary institution, which extended many courtesies to Doctor

FIG. 36.—A street scene in Shanghai.

Hitchcock. Nanking is a thoroughly Chinese city showing little foreign influence. Like most Chinese cities it is surrounded by a high wall, this one being 32 miles in length and 30 to 50 feet high. Kuling is a resort on a mountain south of the treaty port Kiu Kiang, where the missionaries and other foreigners of central China congregate during the summer.

During the visit of Doctor Hitchcock the Yangtse River was in flood and the rice fields of the valley were covered with water. The unfortunate peasants were in the water up to their waists or even to their shoulders cutting the rice and placing it in small circular

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FIG. 37.—A typical valley at Nanking, China, showing intensive cultivation. There is a fish pond in the left foreground. The hills on each side of the valley are covered with grass, much of which will be cut and used for fuel.

FIG. 38.—A ricksha party just after passing out through one of the main gates of Nanking China. The city wall is about 50 feet high.

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FIG. 39.—The Yangtse Valley above Nanking in flood. View from a river steamer.

FIG. 40.—Slender pieces of split bamboo drying in the sun. From these joss sticks are to be made.

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boats. The bundles were supported on the ends of crossed poles on the dikes to hold them out of the water to dry.

FIG. 41.—A clump of bamboo, Canton, China. A common ornamental plant.

The gateway to south China is Hongkong, a very mountainous island owned by the British, the peak being 1,800 feet high. There is here a botanic garden and a herbarium. Canton lies up the river west of Hongkong about 80 miles. Opposite Canton on the island of Honam is the Canton Christian College, where Doctor Hitchcock

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made his headquarters. Excursions were made to Yingtak and Shiuchow on the North River north of Canton, to Lohfau Mountain east of Canton and north of Sheklung, to Wampoa 10 miles east of Canton, where the Wilkes Expedition made collections, and to Macao, a Portuguese possession 40 miles from Hongkong and the oldest foreign settlement in this region.

A more extended trip was made in company with Mr. McClure of the Canton Christian College, to Indo-China and the Island of

FIG. 42.—A street scene in Yingtak, on the North River, about 80 miles north of Canton. The bundles of stalks are to be used for firewood.

Hainan. Going from Hongkong to Haiphong, a stop was made at Pakhoi on the southern coast of Kwantung Province. Here forty-six species of grasses were obtained in a few hours on the sandy areas and rocky hills. Haiphong is the port of Tongking. Indo-China is a French Colony (officially French Indo-China), consisting of five divisions, Tongking, Annam, Cambodia, Cochin-China, and Laos. The objective in Indo-China was Hue, the capital of Annam. Loureiro, a Portuguese botanist, resided here and published in 1790 a flora of Cochin-China and it was to determine the identity of many of

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his grasses that this interesting city was visited. To reach Hue one goes by rail to Hanoi and then south to Vinh, the present terminus of the railroad that is to be built to Hue and ultimately to Saigon. Beyond Vinh one goes by auto-bus over good roads about 175 miles. A trip was made to Tourane on the coast, connected with Hue by railroad.

On the return trip from Haiphong to Honkkong, a stop was made in Hainan, landing at Hoihow on the north coast. Hainan is a seldom-visited island about 180 miles long, belonging to China.

FIG. 43.—A wayside shrine at Yingtak, China. These shrines are common but, like the present one, often suffer from neglect.

Through the kindness of Doctor McCandliss, a missionary in charge of a hospital at Hoihow, we were able to penetrate to the interior of the island as far as Kachek where there is a branch missionary station. The journey was made by boat on the river the first day and on foot the second and third days. From Kachek a trip was made up the river into the foothills of the Five-finger Mountains. Traveling in Hainan as in many other parts of China is chiefly by chair carried by two coolies.

Traveling in China is mostly by rather primitive methods. Modern steamers ply along the coast and on the larger rivers and there are a few railroads. The sampan, a small partly covered boat propelled by

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oars, is common in the harbors. In the cities where the roads are wide enough the ricksha (jinrikisha) is used. This is a two-wheeled cart, mostly now with pneumatic tires, drawn by a coolie, and holding

FIG. 44.—A sampan at Shiuchow. This is the common type of small boat used on the rivers of south China. The bamboo pole is used to push the boat in shallow water. Oars are used in deeper water.

one person. In the narrow streets of the cities where there is not room for rickshas, and on the country trails or paths, chairs are commonly used. These are covered seats supported by two poles and carried by two coolies. Long journeys in them are far from com-

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fortable. In the part of China visited animals are little used for transportation of any kind. Freight is carried on land by man-power, one man with a pole supporting two weights, two men with

FIG. 45.—A specimen of the traveler's tree, growing in the botanical garden at Huê, the capital of Annam, French Indo-China. The plant is a native of Madagascar.

a pole supporting one weight, heavy loads on rude wheelbarrows, in the cities heavy loads, as much as a ton, on carts pulled and pushed by several men.

One of the curious sights to one visiting China for the first time is the enormous number of graves distributed at random over the

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country. Thousands of little mounds are to be seen on every hand, some hemispherical and grass-covered, some more elaborate, with stones or masonry.

The agriculture of China is intensive and in some ways much in advance of ours. The rice fields show usually a perfect even stand, and the amount per acre is the maximum. It represents a large amount of labor as every stalk is set out and harvested by hand.

The botanical results of the trip were very satisfactory, a large and valuable collection of grasses having been made.

BIOLOGICAL EXPLORATION IN THE DOMINICAN REPUBLIC

In November, 1920, Dr. W. L. Abbott revisited the Dominican Republic, working in both the Samaná Peninsula and the region lying between Sánchez (at the head of Samaná Bay) and Puerto Plata, on the north coast. Already familiar with much of this territory, he was able to investigate a number of new and very interesting localities. Two weeks was spent at Sánchez; three weeks in the vicinity of Samaná, a town on the south coast of the Samaná Peninsula about 20 miles east of Sánchez, and on the mountain known as Pilón d'Azúcar; seven weeks at several stations along the railroad connecting Sánchez and Puerto Plata, among which were Villa Riva, Pimentel, Cotuy, Mao, and Navarrete; two weeks in the easternmost portion of the peninsula, in visiting Las Cacaos, Rojo Cabo, and Cape Samaná; one week on the south coast of Samaná Bay in the vicinity of San Gabriel; and one week in the region of Old Heart River, in the north-central part of the peninsula.

Contrasting with the remaining part of Hispaniola, the population of the Samaná Peninsula is chiefly English-speaking, due to the fact that Samaná was settled by a colony of Philadelphia negroes under President Boyer of Haiti in 1820-22. The region is well watered and has a luxuriant vegetation, and provisions are plentiful and relatively cheap. The hills extending north to the coast from Pilón d'Azúcar are covered with unbroken forests.

The Yuna River forms a vast swamp, which occupies the entire region at the head of Samaná Bay and extends along the railroad for a distance of 12 miles. West of this swamp region, in the vicinity of Villa Riva, Pimentel, and Cotuy, are vast stretches of grassy savannah. The soil is fertile, and the inhabitants are industrious and prosperous. Beyond this region the land, except along the streams, becomes arid and the towns, such as Guaybin, Navarrete, and Mao, are small, poorly provisioned, and lacking in enterprise.

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FIG. 46.—View down Río Mao from schist outcrop near Bulla; cliffs of conglomerate in the distance.

FIG. 47.—View along the Río Mao, near Cercado de Mao.

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Numerous caves provide an interesting feature on the south coast of Samaná Bay, one of them comprising nearly the whole interior of San Gabriel Isle. A cave at the mouth of Naranjita River contained a quantity of Indian bones and pottery.

A collection of about 4,000 plants was procured, representing 1,460 numbers. Of these about 20 per cent are ferns, one being an interesting new species of *Anemia*.

The birds obtained by Doctor Abbott on this visit totaled thirty-one skins, with a few skeletons and eggs, chiefly representing species not previously collected by him. Of particular interest is a whip-poor-will

FIG. 48.—Harbor of Puerto Plata, looking north from Monte Isabel de Torres.

(*Antrostomus*), closely related to a species found in Cuba, but not hitherto recorded from Santo Domingo. On the natural grassy plains on the north side of the island he secured several specimens each of the local form of the grasshopper sparrow (*Ammodramus savannarum intricatus*), and of the stone-plover or thick-knee (*Oedicnemus dominicensis*), both new to the museum collections. The thick-knee belongs to a family of birds resembling overgrown plovers, and is related to them. It occurs in the West Indies only in Santo Domingo, but allied forms are found in suitable localities in Central and South America. The family is chiefly an Old World one, and for the most part tropical in distribution. The Santo Domingo species is well-known to the natives, under the name " boukera," and tame individuals

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are often kept about the houses for the purpose of ridding the premises of insects and spiders.

In addition many land shells and a considerable quantity of ethnological material were secured. Doctor Abbott left New York about the middle of December, 1921, on another expedition to the island, but thus far no information or material has been received from him.

EXPERIMENTS IN HEREDITY

Progress in the experiments in heredity conducted under the joint auspices of the Smithsonian and Carnegie Institutions by the writer, Dr. Paul Bartsch of the U. S. National Museum, have from time to time been published in this pamphlet and in the Year Book of the Carnegie Institution. A summary of the results attained up to 1920 was published as "Experiments in the Breeding of Cerions" in 1920, volume 14 of the Department of Marine Biology of the Carnegie Institution, pp. 3-55, pls. 1-59.

The reported loss of the Cerion colonies introduced into the Tortugas which were said to have been wiped out by the hurricane of September, 1919, made it necessary to revisit the Bahamas to secure additional breeding material for the heredity experiments. Accordingly, passage was secured at Miami on the power schooner "Tecoma" for Nassau, New Providence, on May 18, and there the services of the power boat "Standard J" were secured for a trip to Andros.

The desired adolescent specimens of *Cerion viaregis* were obtained along King's Road, Bastian Point, South Bight, Andros, with considerable difficulty because the agricultural efforts on the part of the local population have shifted to the ground that was occupied by the Cerion colonies during our 1912 visit.

The colony of *Cerion casablancae* has met with even greater misfortune, for sheep and pigs have been introduced into the region occupied by this species, and the larger vegetation has been cut down in order to furnish more opportune habitat for grass culture. These new environmental conditions promise well to exterminate this colony. The necessary material for the experiments was secured with great difficulty.

A trip was next made through South Bight to the western end of Andros and then back to the eastern shore through Middle Bight. On this journey many stops were made and Cerions were gathered in large numbers. The localities from which they were taken were carefully listed so that it will be possible to go back to the same spot in

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the future and gather material for comparison with that now resting in the National Museum.

There were several points of interest as far as the physical features of the locality visited were concerned. In 1912 the waters of the western end of South Bight were of a creamy consistency and the land areas adjacent low flats, mud cracked, with flakes of oolitic rock. On the present visit South Bight was found to be a perfectly clear stretch of water with well-packed bottom with an abundant growth of aquatic plants, while the land adjacent gave the impression of moss covered flats. The green element, however, was due to blue-green algae, which appear to serve as a binding factor.

The trip was enlivened by an iguana hunt, which resulted in the securing of several of these large lizards which are now in the collection of our Zoological Park.

Returning to Nassau, five days were spent exploring the cays off the northwestern shore of New Providence and the adjacent mainland. Here large collections of Cerions were made, the location of each colony being carefully noted, so that these likewise may serve as a check series for comparison with future generations produced in place.

On June 3 Dr. Bartsch returned to Miami and on the following day set sail for the Tortugas, stopping to examine the various plantings along the Florida keys.

It was a pleasure to find that the hybrid colony on Newfound Harbor Key, around which the greatest interest centers just now, had escaped being wiped out by the hurricane. Evidently the rain preceding the hurricane had caused the Cerions to take to the ground, as they are wont to do for foraging purposes under such circumstances, and the dense mats of grass here had kept them from being swept away by the floods that had passed over them, a most fortunate state of affairs. A large number of dead specimens were nevertheless found, which have been placed in the National Museum for record.

Incidentally, it may be stated that another almost fledged young great white heron was discovered on White Heron Key, the island that furnished the specimen that was shipped to the Zoological Park two years ago. The present specimen, which is probably a younger brother or sister of the former sending, was also transmitted by parcel post to the Zoo, where it arrived in good condition.

In " Experiments in the Breeding of Cerions," there are given on page 46 detailed measurements of 100 specimens representing the check series of *Cerion crassilabris* from Balena Point, near Guanico

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Bay, Porto Rico, which were planted on Loggerhead Key in 1915. These were figured on plates 48 to 50. On page 47 measurements were given and on plate 51 figures of 36 adult shells of the first Florida grown generation which were gathered in January, 1919. This year a much larger series of first generation material was found, and 200 of such specimens were measured.

The summaries of these measurements show that no appreciable changes in measurements have taken place in the first generation of Florida grown *Cerion crassilabris*. The measurements in size all fall within the limits of variation, as denoted in the check series, excepting one, *i. e.*, a single specimen which was found among the 200 of the first Florida grown generation that had a diameter 0.2 mm. less than any in the check series. There is no doubt that one could find an individual giving such a measurement among the specimens on the native heath of this species, for the check series was not a selected one, but a hundred specimens taken at random.

COMPARISON OF MEASUREMENTS OF FIRST FLORIDA GROWN CERION CRASSILABRIS WITH THE CHECK SERIES

		No. whorls	Altitude	Greatest diameter
Average	Check series	9.55	22.13	12.41
	First generation	9.13	22.36	11.89
Greatest diameter	Check series	10.5	27.5	13.9
	First generation	10.4	25.7	13.2
Least diameter	Check series	8.5	19.0	10.6
	First generation	8.6	19.6	10.4

It is interesting, therefore, to note that so far as the first generation of this Porto Rican Cerion is concerned, it is in complete agreement with the facts adduced from the two Bahaman species.

The hurricane of 1919 destroyed the cages in which had been placed a specimen of each of two species, in order to determine their ability to hybridize, and to note the results of such crosses as might be observed from such selected individuals.

A new set of cages was therefore prepared. Eleven groups of these cages consist of four compartments, each a cubic yard in size. The septa between compartments are double wire walls to prevent possible mating through the meshes of the fine Monel metal wire screen. In each of these cages there were placed a Hymenocallis plant, some grass and dead wood rubbish, in other words, habitat conditions which were found to be favored by Cerions at the Tortugas. Then two half-grown specimens, one of *Cerion viaregis* and one of *Cerion incanum* from Key West, were placed in each of the forty-four

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compartments. These cages are securely anchored, and every precaution has been taken to make sure that the mollusks will be confined within them, and that no extraneous individuals can find entrance. The cages are arranged as shown in the following diagram, and a better idea of them may be formed from the photograph (fig. 50).

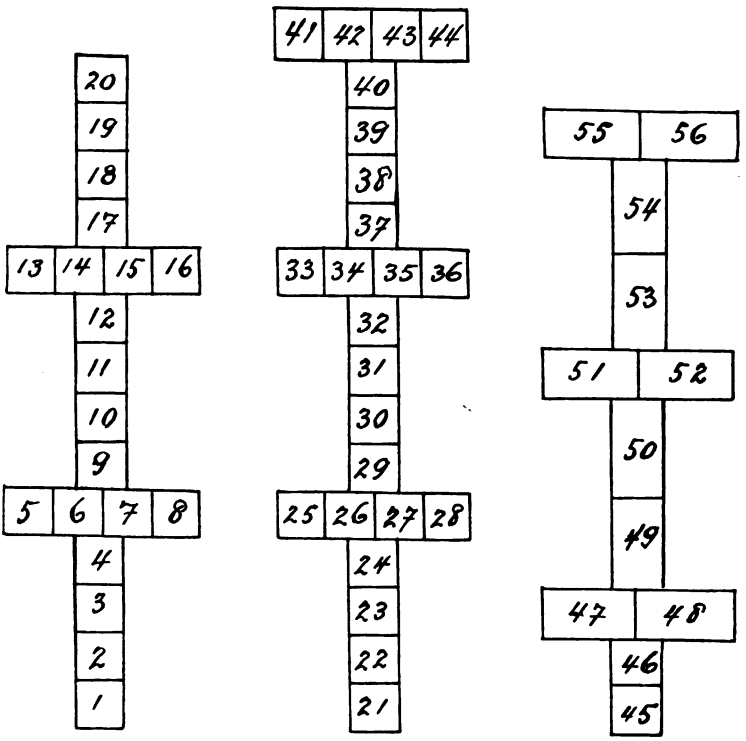

FIG. 49.—Diagram showing arrangement of cages.

Cages No. 45 and No. 46 are of the same size as those last mentioned. In cage 45 were placed 183 young of *Cerion incanum* from Key West, in order to determine what percentage of these will reach maturity. In cage 46 was placed an abnormal specimen of *Cerion viaregis*. This had a spiral keel, which may be the result of an injury, although Doctor Bartsch was unable to discover any sign of it. With it was also placed a normal specimen of *Cerion viaregis* in order to determine if this character might be transmitted to offspring.

In addition to these, five groups of cages were made which have the same size as the four unit cages, but they have only one partition in

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the middle, thus making them 3 by 6 feet, and 3 feet high. In these there were placed the following combinations:

No. 47, 25 each of *Cerion incanum* and *Cerion viaregis.*

No. 48, 25 each of *Cerion incanum* and *Cerion casablancae.*

No. 49, 25 each of *Cerion incanum* and *Cerion uva.*

No. 50, 25 each of *Cerion incanum* and *Cerion crassilabris.*

FIG. 50.—A portion of the monel metal wire cages used in Cerion breeding experiments.

No. 51, 25 each of *Cerion viaregis* and *Cerion uva.*

No. 52, 25 each of *Cerion viaregis* and *Cerion crassilabris.*

No. 53, 25 each of *Cerion casablancae* and *Cerion uva.*

No. 54, 25 each of *Cerion casablancae* and *Cerion crassilabris.*

No. 55, 25 each of *Cerion uva* and *Cerion crassilabris.*

In cage 56 there were placed 203 young of various sizes of the huge new form collected in Middle Bight, Andros, which Doctor Bartsch has called *Cerion mayori.*

Two additional species were introduced this year on Loggerhead Key, one *Cerion mayori,* as above stated, and the second, *Cerion incanum,* as also stated above, but of this species a large colony was

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also placed about the water tower at the northern end of the island, in order to have additional material if it should be needed for breeding purposes in the future.

While at the Tortugas a careful bird census was made, as usual. By the use of a blind, a series of photographs of the beautiful roseate tern, nesting here abundantly, was secured. The accompanying illustration shows one of these birds together with an unhatched egg and a babe.

FIG. 51.—Roseate tern, young, and egg. Bush Key, Tortugas, Fla.

ENTOMOLOGICAL EXPEDITION TO ALASKA

In May, 1921, Dr. J. M. Aldrich, Associate Curator of Insects, U. S National Museum, was detailed to collect insects in Alaska, especially in the interior. The museum had very little material from Alaska, except from the coast region. The government railroad, extending from the southern coast north to Fairbanks, was nearing completion, and offered opportunity for travel not heretofore existing. It appeared also that the completion of the railroad would probably lead to an increase of population which would create greater interest in the insects of the region.

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Doctor Aldrich left Seattle May 30. The steamship made some stops for unloading freight, enabling him to collect one day at Skagway and one day at Valdez. The coast region is fairly familiar to tourists, with its innumerable islands, steep shore-line, snow-capped mountains and numerous glaciers (figs. 52-56). Seward was reached on June 9. The government railroad begins at this point and close connections were made with a waiting train. The railroad passes over rugged mountains in the Kenai peninsula close to several large glaciers; it then descends to sea-level at Turnagain Arm, keeping near the shore line to Anchorage. This was the first collecting point which might be considered to represent the fauna of the interior. Although

FIG. 52.—Cannery near Juneau, Alaska.

it is on tide-water it is behind the coast range and has the dry climate characteristic of the interior. The town is on a level glacial plain, several miles wide, covered with a light forest and having a thin soil upon quite recently deposited gravel. The forest is composed of spruce, aspen, birch, alder and willow. After several days collecting here the journey northward was resumed. Steel had been laid as far as Hurricane, 285 miles from Seward. On arriving here Doctor Aldrich was furnished a horse by the Alaskan Engineering Commission and rode along the right-of-way for 85 miles across Broad Pass and down the Nenana River to Healy, which was at the time the terminus of the rails laid southward from Nenana on the Tanana River. Only casual collecting was done until Healy was reached, but here it was necessary to wait several days for baggage to be brought from Hurricane by wagon. This proved to be a very good collecting

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point as it is at the mouth of the canyon on the edge of the Yukon Valley, thus combining to some extent the mountain and plain fauna. After five days here, Doctor Aldrich went north on the railroad to Nenana, collected there for only part of a day and continued the following day on the narrow gauge line, recently acquired by the government, to Fairbanks, his destination. It had been intended to spend

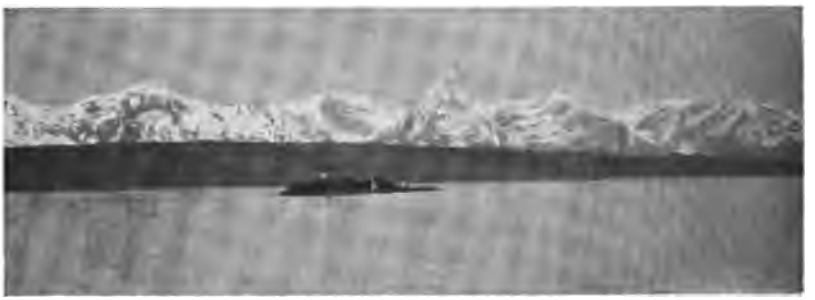

FIG. 53.—North side Lynn Canal near Skagway, Alaska.

FIG. 54.—Glacier on Lynn Canal, Alaska.

most of the collecting time in the vicinity of Fairbanks, but the trip had taken much longer than expected, so he stayed only a week at this point.

The Tanana Valley at Fairbanks is typical of the Yukon Valley in general, as far as the species of insects are concerned. Although it is within about 100 miles of the Arctic Circle, it has a fairly hot summer on account of the extremely long period of sunshine in the day. Some farms are developed and the government experiment station has been demonstrating for many years that the usual garden

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vegetables of the northern states as well as some cereals can be grown. The aspect of the light forest is much like parts of northern Minnesota and the regions about Lake Superior generally: the insects collected

FIG. 55.—Port Althorp, Alaska (merely a cannery).

FIG. 56.—Looking north from Tannel Station, Alaska. Valley filled with glacial gravel in part very recent.

were mostly species occurring in the region named and eastward to the Adirondacks and New England.

A return trip was made along the same route, with stops at Healy and at some of the construction camps on the unfinished part of the

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FIG. 57.—A good insect collecting ground on Ship Creek, near Anchorage, Alaska.

FIG. 58.—Homesteader's cabin near Anchorage, Alaska.

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FIG. 59.—Outskirts of Anchorage. Log houses make up almost the whole town, and are the usual thing in Alaska.

FIG. 60.—Outskirts of Anchorage, Alaska. Half-cleared land.

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road. The bad condition of the wagon road along the right-of-way south of Healy had reduced wagon travel to a very low stage. The only wagons using the road were those of the Alaskan Engineering

FIG. 61.—Spruce forest on Chulitna River near Mount McKinley.

FIG. 62.—Hurricane, a construction camp on the government railroad 285 miles north from Seward, Alaska.

Commission, carrying supplies to the camps. As each wagon turned back on unloading, and only a few were in use at the time, considerable delay was encountered in getting baggage moved from Healy to

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Hurricane. This delay could have been used to good advantage for collecting except for the fact that the weather became cloudy and windy and very unfavorable. Doctor Aldrich, after several days delay, went on to Anchorage and spent a few more days collecting there while awaiting his baggage. Here the weather was again favorable so that the result was very good. Resuming his journey Doctor Aldrich went to Seward with the intention of spending at least ten days in getting a collection of the insects of the humid coast region. The weather, however, gradually became more rainy, greatly limiting the result and finally making it expedient to take the boat from Seward about a week after arrival.

FIG. 63.—Middle fork of Chulitna, a little south of Broad Pass. Corduroy bridge of the Alaskan Engineering Commission.

The expedition resulted in the accession of about 10,000 specimens of Alaska insects, nearly all from the interior region. As far as they have been studied up to the present time they indicate three somewhat distinct faunal regions in the territory covered.

First, the maritime fauna consisting of the insects living upon the seashore and depending upon the ocean for necessary conditions of existence. Insects of this group extend down the coast, in many cases as far as the State of Washington and some even so far as San Francisco; while it is presumed that they would also be found more or less in the Asiatic side of Bering Sea.

The second element is that of the humid mountain region along the coast; a considerable part of this fauna extends to Puget Sound,

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FIG. 64.—Contractors' cabins on the line of the government railroad near Broad Pass, Alaska.

FIG. 65.—Looking northward down the Nenana, Alaska. Unfinished government railroad in foreground and down left side.

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Mount Rainier, and in less degree, to other mountains of the Pacific northwest. The relation of this element to the Asiatic fauna is very little known.

The third element of the Alaska fauna, as far as observed, is that of the dry interior and especially of the Yukon Valley, which has many elements in common with Northern Minnesota, Wisconsin and Michigan, Ontario, the Adirondack Mountains of New York and the White Mountains of New Hampshire. Many of the insects of this group also occur in the Rocky Mountains of Colorado and no doubt further exploration will show that they occur in other mountains of the western United States. Those which represent a more northern

FIG. 66.—Town of Healy in the lignite belt on the Nenana River, Alaska.

range also reappear in Labrador collections, and presumably extend across North America although we have no collections from intermediate points. This element contains many species known from Finland and the Scandinavian Peninsula in Europe, presumably extending in their distribution across Russia and Siberia.

In most orders of insects Alaska has a comparatively large fauna. There are very numerous species of the two-winged flies, or Diptera; and from Doctor Aldrich's long experience with this group he naturally paid especial attention to collecting in this order. Bumble bees and wasps are conspicuous insects everywhere on flowers; and in the absence of darkness bumble bees were observed to work as late as 10.30 at night in Fairbanks. Grasshoppers were strikingly scarce, only two species being found and in all but half a dozen specimens.

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Mosquitoes in the interior are exceedingly abundant, as is well known. Especial attention was given to them in collecting, and two species previously undescribed were among the material brought back. It appears, however, that the most troublesome species are the same ones which occur in somewhat less numbers in the Pacific northwest in occasional favorable localities. Horse flies are very numerous in the region at Fairbanks where they are commonly called moose flies since the moose is more common than the horse.

FIG. 67.—Construction camp at Nenana Bridge, north of Healy, Alaska.

The common house fly was not found at any point in Alaska. Continuous attention was given to this matter, and collections were made at the garbage dumps in Anchorage and Seward; while at Ketchican, the southernmost town in Alaska, grocery stores, restaurants and a cannery were carefully examined early in August without finding any of the flies. Other garbage-feeding flies were studied at every possible point and one new species of blow-fly was collected. The absence of several scavenger flies which are common in the United States was noted.

The exploration of Alaska, especially the interior, from an entomological point of view is important in itself and also forms a link in the study of a much broader problem—that of the entire Holarctic fauna which extends almost continuously around the globe in the vicinity of

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the Arctic Circle. It is a matter of great scientific interest to determine how much of this northern fauna is the same in the new world as in the old, and also to determine how much of the fauna further south,

FIG. 68.—Fairbanks, Alaska, and adjacent country from top of a building.

FIG. 69.—Looking up the Cheva River eastward from Fairbanks, Alaska. Some farms cleared and cultivated on the slopes of the distant hill.

as for instance in the United States, has been derived from this northern region. It is hoped that opportunity will arise to carry this exploration much farther not only in Alaska, where as yet merely a beginning has been made, but also in other northern regions as for instance Labrador, Greenland and Siberia.

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ARCHEOLOGICAL FIELD-WORK ON THE MESA VERDE NATIONAL PARK

During May and June, 1921, Dr. J. Walter Fewkes, Chief of the Bureau of American Ethnology, continued his archeological work of former years on the Mesa Verde National Park, Colorado, the brief season's field-work being financed with a small allotment from the Bureau of American Ethnology.

The site chosen for field operations was the Mummy Lake cluster of mounds, a typical prehistoric southwestern village situated 4¼ miles north of Spruce-tree Camp. One of the mounds in this village, excavated in 1916, is now known as Far View House. The surface contours of the remaining mounds differ somewhat, indicating that the buildings hidden in them have different forms, but excavations are necessary to determine the use of these buildings. It has long been known that some of the prehistoric pueblos of our southwest had rooms called kivas for religious purposes, but only within the last year has it been recognized that there was sometimes added to these kivas a complex of rooms, also for ceremonial purposes. Several of these specialized religious structures have already been described, but there remain many other mysterious mounds beckoning the archeologist for excavation and accurate identification. How many different types of buildings designed solely for ceremonials there are in our southwest, time will reveal.

The word house (*ki*, Hopi) is applied in prehistoric cliff-dwellers' nomenclature to a compact collection of inhabited rooms, secular and religious (fig. 70). A pueblo is such a communal dwelling; but a group of uninhabited rooms, each and all constructed for ceremonial purposes, should bear another name. The discovery of Sun Temple introduced archeologists to a type of southwestern buildings not intended for habitations, but for a specific communal purpose supposed to be religious. Fire Temple, on the Mesa Verde, is also regarded as such a specialized building and is likewise believed to have had a religious use. Similarly, Cedar-tree Tower and Far View Tower were not habitations but communal buildings with a religious function. The "Lower House" at Yucca House National Monument, the "Great Kiva" at Aztec, and similar great kivas situated in the Chaco Canyon and elsewhere on tributaries of the San Juan River morphologically belong to this type. All these may be called temples. There are many large buildings never inhabited but now in ruins scattered over the southwest, the use of which is doubtful. Among these are

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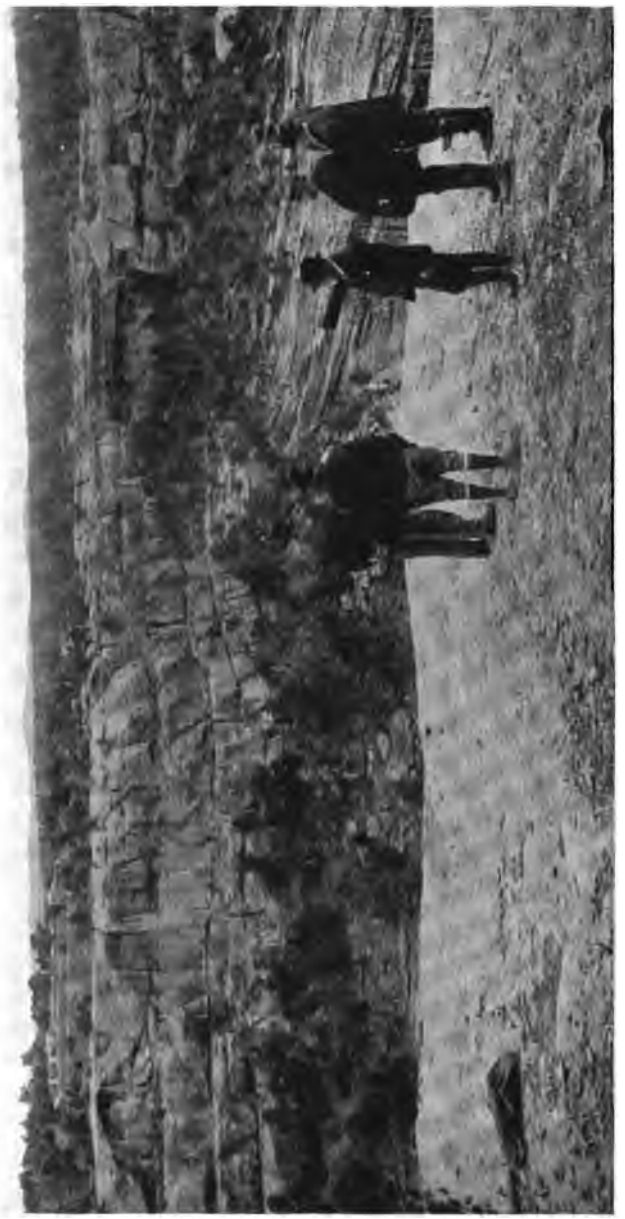

FIG. 70.—Sun Temple and Cliff Palace: from Sun Point, Mesa Verde National Park. (Photograph by Geo. L. Beam. Courtesy Denver and Rio Grande Railroad.)

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the so-called fire houses or " houses " of the Hopi fire people and the twin mounds conspicuous on the mesa top above Sikyatki, which may on excavation be found to have been devoted solely to religious purposes.

FIG. 71.—Far View Tower and Kiva, partially excavated. Mesa Verde National Park. (Photograph by Fewkes.)

This specialization in the San Juan Valley of buildings showing functional differentiation in structure is indicative of a high cultural development. It is instructive to find that it is confined to prehistoric stages of development and is most abundant in areas where sedentary inhabitants had disappeared before the advent of Europeans.

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The plan of the work of the Bureau on the Mesa Verde National Park in 1921 was to investigate a conspicuous and centrally placed mound not far from Far View House. The indications are that this was an ancient necropolis of the Mummy Lake Village, combining subterranean rooms or kivas with a large cemetery situated on the southern side of a high tower. Unfortunately, this cemetery had been rifled several years ago by vandals; but the many fragments of pottery found on the surface betray features important in cultural comparisons.

Far View Tower was relatively an ancient building; its architectural form is characteristic and its pottery decidedly archaic as compared with that of the golden epoch of geometric decoration from Cliff Palace or Spruce-tree House. We may never know in what century this tower was built, but its construction can be referred to an older epoch than the great cliff dwellings of the park, which were probably inhabited as late as 1300 A. D. The refuse heaps of cliff houses have so little depth that a stratification or superposition of pottery shards is too small to afford satisfactory evidence of long occupancy. In historic refuse heaps of pueblos now inhabited they are thicker and the stratification method has proved advantageous; but nothing that was not already known has been added to our knowledge of the sequence of prehistoric pottery of cliff houses by this method of study. No Mesa Verde refuse mound has yet shown any difference in the character of pottery found on its surface and at its base. The pottery fragments of mounds containing relics of earth lodges are as a rule cruder than others. The pottery from the cemetery or necropolis of Far View Tower is rudely decorated ware, while that from Far View House is finer, but not as well made as that from Spruce-tree House. It is probably older than the pottery from Far View House, but both are more ancient than the pottery from Spruce-tree House.

Far View Tower (fig. 71), like Cedar-tree Tower, has one and possibly more subterranean rooms or kivas on the south side, but the latter lacks the large cemetery. The use to which Far View Tower was put and the significance of the relation of the accompanying kivas to it were probably not very different from those at Cedar-tree Tower, discovered last year (1920). Evidently the complex was devoted to some archaic cult, like fire worship.

In addition to the work above mentioned, Doctor Fewkes also excavated Painted Kiva House, a small prehistoric cliff dwelling situated on the Mesa Verde a short distance north of Cedar-tree Tower, under the rim of the west side of Soda Canyon. This ruin was excavated and described by Baron Nordenskiöld, who called it Ruin 9. It contains remains of two well-made kivas of the regular

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circular Mesa Verde type and of several granaries and living rooms. The approaches to it from the mesa rim are very precipitous and it was necessary to construct four ladders and otherwise improve the trail to enable visitors to see it.

On the walls of one of its two kivas there survives a very good example of decorated plastering. As shown in the accompanying illustration (fig. 72) there is a dado or lower part of the kiva wall which is painted red, and on its upper edge there are arranged at intervals clusters of triangular symbols (three in number) around which extends a row of dots. The Hopi identify these triangles as

FIG. 72.—Interior of kiva, showing mural decoration, niches, and pilaster. Painted Kiva House, Mesa Verde National Park. (Photograph by Fewkes.)

symbols of butterflies. They are of common occurrence on the walls of several kivas and survive in certain secular rooms of the cliff dwellers. These triangles with surrounding dots occur constantly on the oldest cliff-dweller pottery, as shown in the accompanying figures. The ventilator shaft is represented in the painted kiva by a tortuous passage, extending under walls and opening some distance from the room. It is spacious enough to serve as an entrance into the ceremonial chamber. Although Baron Nordenskiöld made extensive excavations in Painted Kiva House and devoted several pages of his memoir to a description of it and the specimens he found there, many objects (fig. 73) remained in rear chambers which were found in 1921.

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FIG. 73.—Snowshoe frame. Painted Kiva House, Mesa Verde National Park. Size: 14½ inches by 9½ inches. (Drawn by Mrs. George Mullett.)

FIG. 74.—Rim basket. Painted Kiva House, Mesa Verde National Park. Size: 15¼ inches. (Drawn by Mrs. George Mullett.)

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Among the instructive specimens collected in Painted Kiva House should be mentioned a rim basket (fig. 74) and a woven headstrap of yucca fiber. The unique object shown in figure 75 reminds one

FIG. 75.—Unidentified object. Painted Kiva House, Mesa Verde National Park. Size: 5¾ inches long. (Photograph by De Lancey Gill.)

of Navaho "*bugaboos*," sometimes found farther down the San Juan but not yet recorded from Mesa Verde. In a rear room which gave every evidence of having been a granary or bin for storage there were found numerous ears of corn with kernels entire, beans, and squash seeds. The belief is widespread that cliff-dweller seed corn when

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planted will germinate, but all experiments in that direction have failed. There is no hope that any greater success will reward experiments made with corn from this granary. In the centuries that have elapsed since the mesa was deserted, corn seed left behind has lost its vitality.

The walls of a ruin called Mummy House, situated almost directly under Sun Temple, are among the most carefully constructed on the park. This ruin has one kiva which was cleaned out but not repaired. A mummy (now in the Mesa Verde Park Museum) was found in this ruin several years ago. Above it is Willow-tree House, practically inaccessible. Ladders were put in place connecting the trail up the canyon with Mummy House. A typical form of cliff house called Oak-tree House, before and after repair, is shown in figures 76 and 77.

One of the important ruins on the Mesa Verde, called Step House by Nordenskiöld, is situated in a cave 5 miles west of Spruce-tree Camp. It presents to the archeologist one of the most instructive problems on the Mesa, and should be put in shape for visitors. In the floor of this cave, which has been considerably dug over by Nordenskiöld and others, there was material bearing on a most interesting chronological problem, viz., the age of the cliff houses; for the artifacts in this place represent two different epochs in the cultural history of the pure pueblo-cliff-dwelling type. Out of the floor of the cave there projects the edges of upright slabs of stone showing the existence of cists like those in Earth Lodge A. These suggest the slab-house culture; but at the other end is a building in the highest form of horizontal masonry. The probability is that the former is the older construction or that it was built by the most ancient people of the park, who lived and were buried in that end of the cave, designated by Nordenskiöld a cemetery. Here we have evidences, both architectural and ceramic, of former earth lodges or fragile walled buildings of the prepuebloan or archaic culture. The original dwelling built by people when they moved into Step House Cave was an earth lodge, and the dwelling with horizontal masonry and kivas, at the other end of the cavern, was a later development. The pottery of the former is more archaic than that of the latter. Figure 78 illustrates the most highly developed Mesa Verde pottery. We have, in other words, indications of two distinct stages of development in Step House Cave—one the earth lodge and the other the pure pueblo or kiva style; the former or earth construction situated at one end of the cave, the latter stage at the other. This evidence of two stages of

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FIG. 76.—Oak-tree House, before repair. (Photograph by Geo. L. Beam. Courtesy Denver and Rio Grande Railroad.)

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FIG. 77.—Middle room of Oak-tree House, repaired. (Photograph by Geo. L. Beam. Courtesy Denver and Rio Grande Railroad.)

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development in the same cave is derived from both ceramic and architectural studies. The indications are that after the earth-lodge condition was outgrown the floor of the cave where the evidence occurs was used as a cemetery, and the survivors constructed their new homes at the other end of the cave in the form of cliff houses. Although no satisfactory scheme of the chronological sequence of different types of Mesa Verde pottery has been worked out, it is most important to pay some attention to its bearing on the age of the above-mentioned buildings.

The mortuary pottery (fig. 79) from the Far View Tower cemetery belongs to a primitive type quite unlike any yet recorded from Mesa Verde cliff dwellings. The most exceptional features are the numerous varieties of coiled, corrugated, undecorated ware. Figure 80, restored from a fragment, and figure 81 show one of these exceptional bowls. A similar bowl with a blackened inner surface occurs elsewhere in the southwest, as on the Little Colorado, but has never been described from the Mesa Verde. A comparison of ceramic objects from the cemetery of Far View Tower (fig. 82) indicates it belongs to an ancient type related to Earth Lodge A, described in the explorations pamphlet for 1919.[1] Attempts have been made to show an architectural evolution from an earth lodge with roof and walls of logs and mud into buildings constructed of well-laid horizontal stone masonry. There is a chronological development in technique, form and decoration of pottery from the simple to the complex, but those who have studied cliff-house pottery have not yet succeeded in arranging the different kinds in chronological sequence.

Each ceramic area in our southwest has its distinct facies. Mesa Verde pottery excels all others in its geometrical decoration. Conventionalized designs and life figures on it are few in number and crude in execution, but linear designs are abundant and varied. In the prehistoric Hopi pottery, where there are few life figures and the majority of designs are geometric or highly conventionalized, there is nothing showing successive steps in the development of designs. In those ruins where geometric figures (fig. 83) predominate there is little to show their evolution. The pottery from the Mimbres Valley, New Mexico, decorated with both fine geometric and realistic figures, gives us no clue to evolution of different typical naturalistic designs. Apparently the three types, geometric, conventional, and realistic, are distinct from their very origin and it is difficult to prove that one type

[1] Smithsonian Misc. Coll., Vol. 72, No. 1.

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FIG. 78.—Mug; black on white ware. Fire Temple House, Mesa Verde National Park. Size: 4 by 4 inches. (Photograph by De Lancey Gill.)

FIG. 79.—Archaic black on white ware; coarse decoration, Far View House Village. Necropolis, Mesa Verde National Park. Size: 5¼ inches.

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FIG. 80.—Bowl; indented corrugated ware with black interior, Far View House Village. Necropolis, Mesa Verde National Park. Size: 4½ by 2⅛ inches. (Repaired by W. H. Egberts.)

FIG. 81.—Detail of indented corrugated bowl, figure 80, Far View House Village. Necropolis, Mesa Verde National Park. (Drawn by Mrs. George Mullett.)

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preceded another in evolution. For the present, then, our knowledge of sequence of types of pottery is largely derived from descriptions and not generalizations. But our archeological method permits us to determine the main features of a stage of culture among the Indians of which little is historically known. For instance, previous to the year 1915 we were ignorant of the manners and customs of the people

FIG. 82.—Archaic black and white ware, coarse decoration, Far View House Village. Necropolis, Mesa Verde National Park. Size: 3½ by 3 inches. (Photograph by De Lancey Gill.)

who inhabited the Mimbres Valley, New Mexico. Documentary history is silent about them. Through archeological studies data are being brought to light year by year by which our knowledge of these Indians is greatly advanced. Pictures on ancient pottery often impart more information than written descriptions and are most important in the study of lost races. During the last few years Mr. E. D. Osborn, of Deming, New Mexico, has from time to time sent to the bureau many unique photographs of mortuary bowls (figs. 84-86), some of

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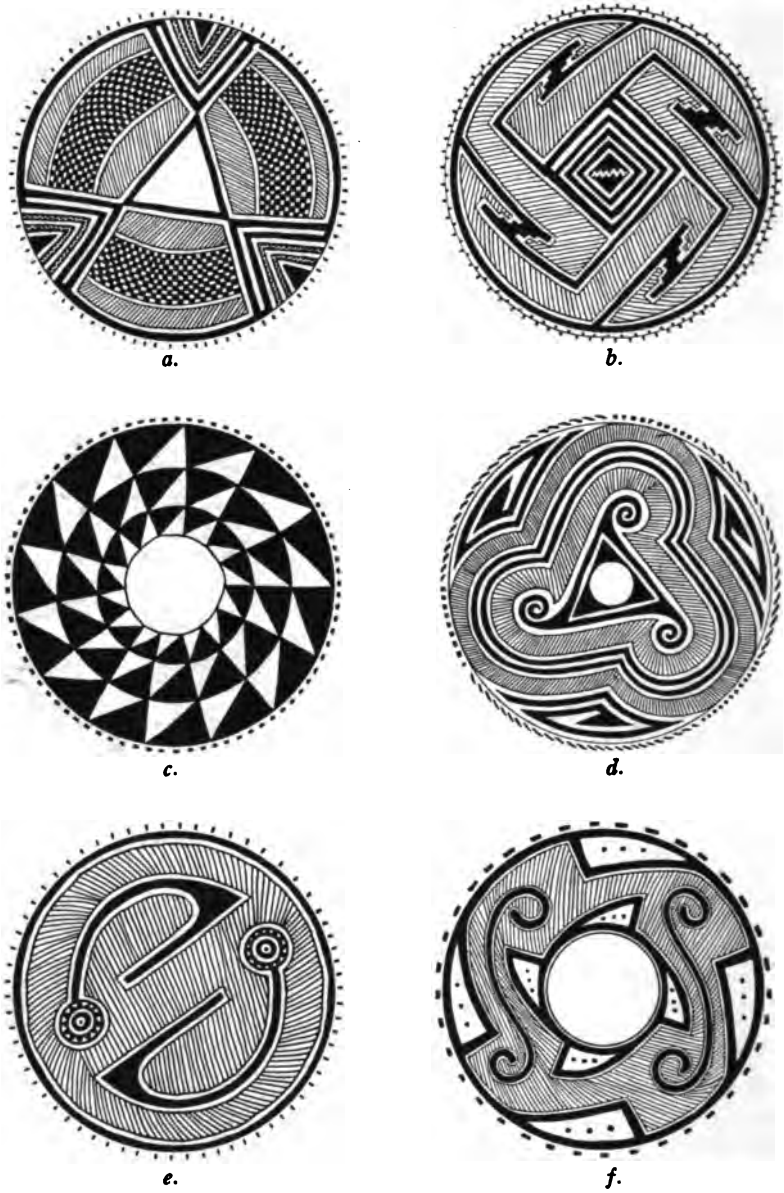

FIG. 83.—Decorated pottery from Mesa Verde National Park. *a*, triangular geometric design; *b*, hatched and terraced line; *c*, black triangles in concentric series; *d*, central triangle with curved lines at angles; *e*, unknown geometric design; *f*, S-shaped design. (Drawn from photograph, by Mrs. George Mullett.)

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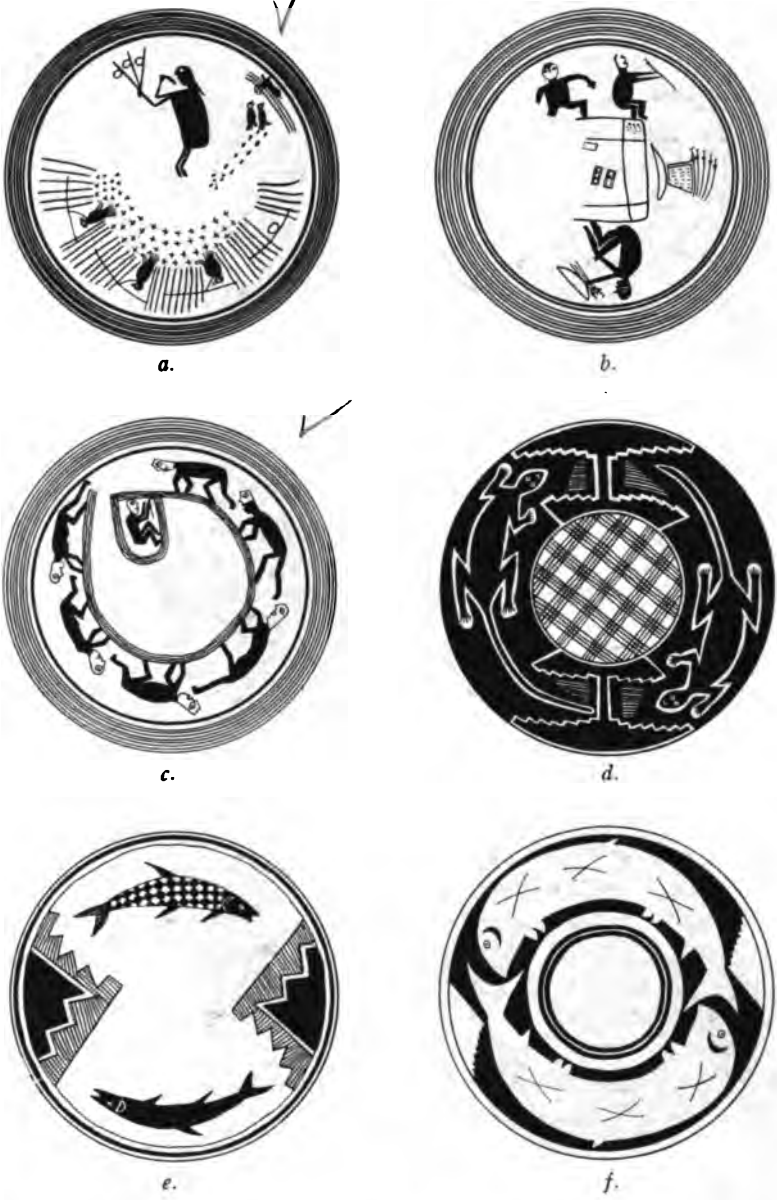

FIG. 84.—Decorated pottery from Mimbres Valley, New Mexico, Osborn Collection. *a*, bird trap; *b*, gambling game; *c*, emergence of man from lower world; *d*, white outline on black ground; *e*, two fishes; *f*, two negative pictures of fishes. (Drawn from photograph, by Mrs. George Mullett.)

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FIG. 85.—Decorated pottery from Mimbres Valley, New Mexico, Osborn Collection. *a*, unknown bird, from back, with outstretched wings; *b*, feathers used in geometric decoration; *c*, three-headed turkey; *d*, parrot, head often repeated as club-shaped design on Casas Grandes pottery; *e*, humming birds and flowers; *f*, unidentified flowers. (Drawn from photograph, by Mrs. George Mullett.)

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FIG. 86.—Decorated pottery from Mimbres Valley, New Mexico, Osborn Collection. *a*, unknown fish with feathered horn; *b*, animal heads like swastika; *c*, sun with four tail feathers; *d*, geometric ornaments; *e*, geometric ornaments; *f*, geometric ornaments. (Drawn from photograph, by Mrs. George Mullett.)

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which are decorated with well-made pictures showing hitherto unknown features of prehistoric life in that valley. Similar pictures have been reproduced in former reports, but several specimens lately discovered are the most instructive yet found. References to a few of these close this account.

The food bowl (fig. 84*a*) apparently represents a hunter snaring birds. He carries three nooses in his hand and in three of the snares that are set are birds, while a fourth is empty. On the opposite side of the bowl there are two other birds that possibly have been captured earlier.

Figure 84*b* represents a prehistoric game of "stick dice." In this design three of the "canes" or dice are represented in a rectangular enclosure around which are seated the players. The stakes are arrows shown in a receptacle deposited above the picture.

Two fishes shown in figure 84*e* call to mind the unusual method of representing certain life figures, men, birds, and other animals, on other pieces of pottery. The background of the two fishes of figure 84*f* is black, the bodies white; a negative picture common on ware from Casas Grandes, Mexico, and peculiar to the inland basin in which the Mimbres lies. The upper beak and eye of the head of the well-drawn parrot is shown in figure 85*d*. This conventionalized head often occurs without the body of a bird or any realistic likeness to a parrot in the decoration of pottery from Casas Grandes and it is interesting to note in this connection that Mr. Osborn claims to have found a mound a few miles from Deming, New Mexico, in which the pottery is practically the same as the well-known Casas Grandes ware.

The body of the animal represented in figure 86*a* is serpentine, but the shape of the head and the possession of fins suggest a water monster. The horn with a cluster of feathers occurs in a similar painting without fins, and may be a representation of the Horned or Plumed Serpent.

As is true of decorations on prehistoric Hopi ware, the feather is sometimes used as a decorative element. The identification of the use of this motive was made by a comparison of the undoubted bird with outstretched wings and well-marked symbolic wing feathers shown in figure 85*a*, and the existence of four clusters of a like design in figure 85*b*. A study of over a hundred decorations, realistic, conventional and geometrical, taken from Mimbres pottery indicates that this lost people of southern New Mexico had reached a very high stage of ceramic decoration. There is evidence that this art was somewhat influenced from outside but mainly developed where it was

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found. It is one of several localized culture areas related to but not necessarily belonging to the pueblo with which it has affinity. It is most closely affiliated with that of Casas Grandes and the southern part of the plateau in which it lies. The environment of this plateau is Mexican, climatically speaking, and the culture will probably be found to correspond. While superior to the Casas Grandes and all other prehistoric Indian pottery in variety and the accuracy with which human and animal figures are drawn, it shares enough with it to hold a place in the same group.

ARCHEOLOGICAL COLLECTING IN THE DOMINICAN REPUBLIC

While engaged in a biological exploration of this republic in 1921 and previous years, Dr. W. L. Abbott of Philadelphia incidentally made a collection of aboriginal Indian antiquities on the north coast, especially around Samaná Bay and the region between it and Puerto Plata, as well as in other parts of the island. No systematic excavations were attempted; the majority of the specimens were either purchased or otherwise obtained. The localities where individual specimens were said to have been found are mentioned in the legends under the illustrations. This accession contains many specimens, one or two of which merit special notice, even if it anticipates a final report.

There is in this collection an exceptionally good water jar of unique form upon the neck of which are incised rude figures of animal or human heads. The body of this jar (fig. 87), instead of being round is roughly four-sided, its base flat, neck constructed bottle shaped. Another bowl (fig. 88), spherical in form, is also unique and the incised figure covers much of the upper surface.

In the collections of every West Indian archeologist there are specimens of burnt clay heads called "zemis" (idols) by the natives. These objects are not idols but broken handles of bowls, portions of which sometimes adhere to them. As broken specimens they teach very little, but if the jar from which they were broken be restored they become instructive. The results of Mr. Egbert's clever reconstruction of the bowls to which three of the handles belong are shown in figure 89, *a*, *b*, and *c*.

The decoration of Santo Domingo pottery, like that from prehistoric Porto Rico, as a rule is limited to handles or lugs of bowls and vases. These heads are attached to the rims of jars or bowls and give us a means of classification. They fall naturally into three distinct types: First, and most common (fig. 89*a*), those where the handles are opposite each other, the handle represented as looking into the bowl;

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second, a less common type, those with handle faces looking outward; and third (fig. 89*c*), rarest of all, those with human or animal heads attached to the rim by the back of the head or lying along the rim

FIG. 87.—Unique vase. Cueva de Roma, Dominican Republic. Size: 8¾ inches. U. S. Nat. Mus. No. 316445.

of the bowl with their axis parallel to it. Santo Domingo pottery as a rule is a coarse biscuit ware, its surface waterworn but smooth, apparently sometimes formerly covered with a red slip, showing, however, no evidence of a glaze. Although in bolder relief than that made by the prehistoric potters who preceded the Carib in the Lesser

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Antilles, the ceramics of the aborigines of the Greater Antilles are more closely related to the work of the Huaxtecs of Mexico than to that of the aborigines of South America.

There are in the Abbott collection representatives of all types of those Antillean idols characterized as three-pointed stones: one (figs. 90 and 91) with head on the anterior point; another (fig. 92), a second type characterized by a head on the side of the cone; a third

FIG. 88.—Globular bowl of thin ware. Locality, Yaqui del Norte, Dominican Republic. Size: 5¾ inches. U. S. Nat. Mus. No. 293016.

type has the cone modified into a head; and lastly one smooth, undecorated specimen, referred to a fourth type. The specimen represented in figure 93 belongs to the first type and has on each side of the base of the cone two shallow circular pits; each of these pits represents a joint of the fore and hind limbs, both of which are cut in relief on the side. Although similar pairs of pits are known on several specimens and accompanying forelegs or arms sometimes appear in relief, no specimen with two pits both having relief representations of limbs has been recorded.

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c.

FIG. 89.—Restored pottery from shards collected in the Dominican Republic, by Dr. W. L. Abbott. Restoration by W. H. Egberts. *a*, food bowl with effigies on rim, facing inward; *b*, effigy bowl with handles in form of heads, facing upward; *c*, food bowl, handles in form of heads transversely placed on rim. Size: *a*, 9½ inches; *b*, 6¼ inches; *c*, 16¾ inches. U. S. Nat. Mus. No. 316454.

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FIG. 90.—Three-pointed stone of first type, from side. Constanza, Dominican Republic. Size, 5¾ inches x 2½ inches. U. S. Nat. Mus. No. 309536.

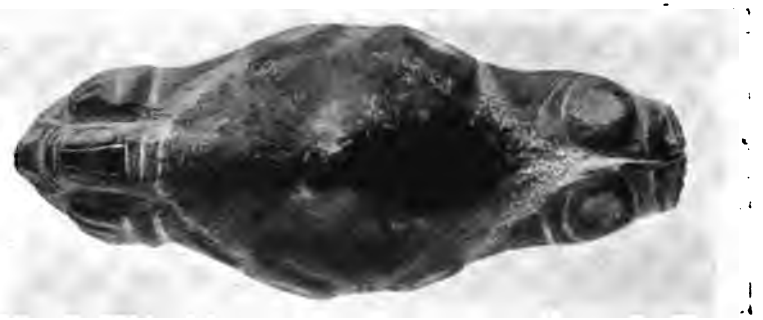

FIG. 91.—Same three-pointed stone from above.

FIG. 92.—Three-pointed stone of second type, from side. Constanza, Dominican Republic. Size: 2½ inches x 1½ inches. U. S. Nat. Mus. No. 309537.

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a. *b.*

FIG. 93.—Front and rear views of three-pointed stone of first type, whose side and top are shown in figs. 90 and 91. *a*, front; *b*, rear.

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There are only seven known specimens of three-pointed stones of the second group, and the U. S. National Museum now has five of these, one of which we owe to Doctor Abbott.

He has also added to the museum collection the three especially fine Antillean amulets shown in figure 94. The form of one—that figured in the middle—is unique. These objects are supposed to have been

a. *b.* *c.*

FIG. 94.—Three marble amulets. Locality, Guayubin, Yaqui River, Dominican Republic. *a*, 2⅞ inches, U. S. Nat. Mus. No. 316448; *b*, 4¼ inches, No. 316446; *c*, 2⅝ inches, No. 316447.

used as fetishes and to have been tied to the foreheads of warriors when they went into battle, as described by Gomara and other early writers.

The cylindrical object of clay with incised figure shown in figure 95 belongs to a type concerning the use of which there has been considerable discussion. These specimens have been identified as rollers for stamping pottery with the design incised on their surfaces; but if

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FIG. 95.—Cylindrical stamp for imprinting pigment markings. Constanza. Size: 2¾ inches. U. S. Nat. Mus. No. 309559.

FIG. 96.—Stone baton. Collected by Col. G. C. Thorpe. Size: 16⅜ inches. U. S. Nat. Mus. No. 316475.

FIG. 97.—Stamp made of pottery, for marking fabrics or imprinting design on the body. Dominican Republic. Size: 2½ inches. U. S. Nat. Mus. No. 309567.

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we judge from the similar objects of aborigines of Venezuela they were more probably used for stamping fabrics or even for printing certain totemistic or other designs on the face or body.

There is in the Abbott collection an artificially worked stone (fig. 96), about a foot in length, which appears to have been used as a

FIG. 98.—Stone Cassava grinder. Yaqui del Norte, Jarabacoa. Size: 12¾ inches x 19½ inches. U. S. Nat. Mus. No. 292998.

baton, possibly a badge of office. One end bears incised designs representing eyes and mouth suggesting a human head.

Figure 97 resembles outwardly a pestle, but a closer examination shows that it is made of clay, a material impossible for an effective grinding implement. It has many pits on the under surface (shown in the figure) which suggests that it was functionally like the cylinder above mentioned used for imprinting paint patterns on the human body or woven fabrics.

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One of several flat stone objects collected by Doctor Abbott having extensions, two "handles" on the rim, is shown in figure 98. In shape and especially in the form and position of the handles these stone implements resemble graters—generally of wood—specimens of which are still in use in Haiti. Stone graters are novelties and those collected by Doctor Abbott are the first of this material added to the museum. It is probable that the surface of this stone was formerly covered with some kind of matrix in which were set sharp stones arranged in an ornamental design that has now completely disappeared, leaving no trace of its former presence.

All the above-mentioned specimens are referred to the Tainan or most advanced neolithic culture of the West Indies, that originated and flourished in the Haiti-Santo Domingo and Porto Rico areas in prehistoric times. The three-pointed idols, stone collars, elbow stones, and characteristic pottery separate the Porto Rico Tainan from that of Jamaica, eastern Cuba, and the Bahamas, which belong to another closely related culture that may be called Cuban Tainan.

The pottery of the aborigines of the Lesser Antilles belongs to an allied prehistoric Tainan culture that was submerged by the Caribs, who inhabited these islands when discovered by Europeans, at the close of the 15th century. The fine addition that Doctor Abbott has made to our West Indian collection all belongs to the true Tainan culture which reached its highest development in Española and Porto Rico.

The archeological specimens from the West Indies presented to the museum by Doctor Abbott are very valuable and as time goes on will be more and more appreciated by students of the history of man in the Antilles.

ARCHEOLOGICAL RECONNAISSANCE OF THE CAHOKIA AND RELATED MOUND GROUPS

David I. Bushnell, Jr., collaborator of the Bureau of American Ethnology, conducted during 1921 a reconnaissance of the remarkable mound groups in the vicinity of the great Cahokia Mound. The information secured at this time, added to notes made during frequent visits in the past, has been used in preparing the following sketch of the interesting region.

It is quite evident that long before Père Marquette discovered and passed the mouth of the Missouri, during his journey down the Mississippi early in the summer of 1673, the region immediately below the confluence of the two great streams had been an important center, a gathering place, of the native inhabitants of the

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valley. Mound groups, village sites, and burial places remain to indicate the presence of a numerous people before the coming of Europeans, and the innumerable objects of native origin encountered

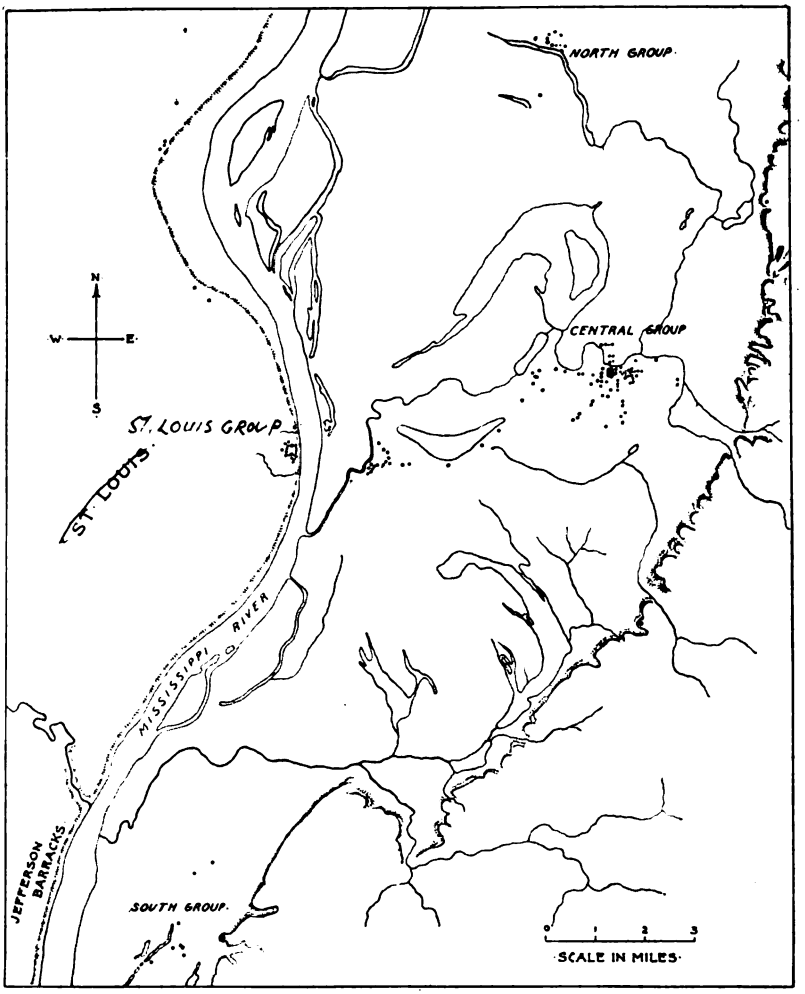

FIG. 99.—Map showing location of mound groups.

in the region bear evidence of their skill in working the available materials.

Immediately below the mouth of the Missouri, on the left or Illinois bank of the Mississippi, the river bluffs become more distant from the stream and consequently the lowlands are in some places 6 or 8 miles in width from east to west. Shallow lakes covered much

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of the surface and some parts were heavily timbered. As indicated on the accompanying map, figure 99, four mound groups stood in the lowlands east of the Mississippi and a fifth was on the opposite bank, land now covered by the city of St. Louis. And as is shown on the map the five groups were placed with a certain degree of order to one another, with the great mound, Cahokia, rising near the center of the area.

But who were the builders of the mounds, the most important groups in the Mississippi Valley? The question may never be definitely answered although it is more than probable they should be attributed to a tribe or tribes known in historic times but who may have become greatly reduced in numbers and relative importance before the coming of the French. Evidently the historic Algonquian tribes did not reach the eastern bank of the Mississippi until about the beginning of the seventeenth century, and it is doubtful if others of this linguistic family had preceded them. Siouan tribes when moving from the eastward may have traversed the region, but there is no reason whatsoever to attribute the great mound groups which form the subject of this sketch to either the Algonquian or Siouan tribes. The works were probably raised by a southern tribe, a southern people who at some time before the arrival of the Algonquian tribes, or the migration of the Siouan tribes from the eastward, occupied the region, later to move elsewhere, possibly to return southward. These may have been the ancient Natchez, the Chickasaw, or some other Muskhogean tribe of whom we possess no historic record; however, a careful examination of the mode of construction and the contents of one or more of the mounds may enable us to arrive at some conclusions regarding their origin.

The great Cahokia Mound which rises from the level alluvial plain near the center of the area, is somewhat less than 6 miles east of the Mississippi and 10 miles east of south of the mouth of the Missouri. It is a truncated pyramid, of rectangular form, with a broad terrace extending from the south side which continues in a graded way or approach. The sides of the work face the cardinal points, as do those of the lesser rectangular mounds of the group. Its maximum elevation is about 100 feet. Its extreme length including the approach is 1,080 feet, and its width from east to west is 710 feet. The base covers an area of approximately 16 acres. Viewed from the east, as in figure 100, it appears quite regular in outline and is clearly defined from base to summit. A small conical mound formerly stood on the

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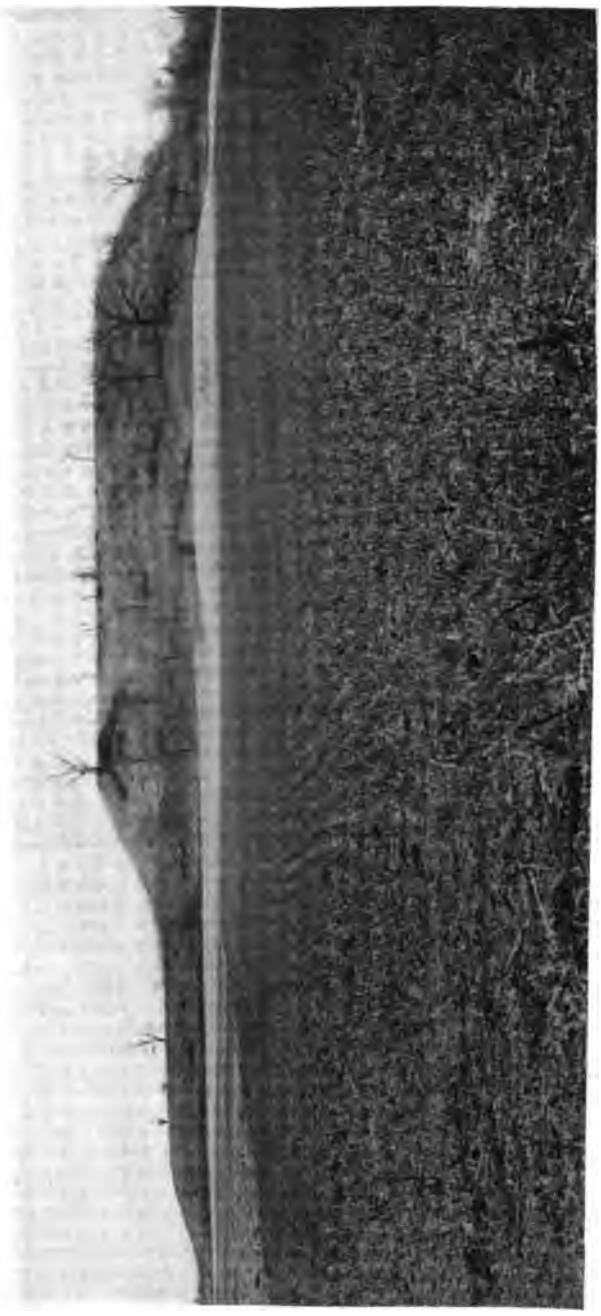

FIG. 100.—Cahokia. The eastern side, with the graded approach on the south.

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upper plateau near the southeastern corner but it was removed many years ago. The northwestern portion of the great mound is deeply gullied and very irregular in contour; it is a question whether this part of the structure was ever completed.

Cahokia is the largest earthwork in the United States and one of the most remarkable monuments left by the native tribes. Fortunately it remains in its original condition, practically untouched since the coming of Europeans, and in this condition it should be preserved. With each succeeding generation, as the lesser mounds and other earthworks disappear by reason of the cultivation of the soil or the requirement of the land for other purposes, this great terraced work is destined to become of greater popular interest and immediate steps should be taken to make certain its preservation.

The several groups, as indicated on the map, may now be described in detail.

NORTH GROUP

Eleven mounds constitute this group which stands on the north side of Long Lake, near the station of Mitchell. They are about three and one-half miles east of the Mississippi, nearly midway across the lowlands and some seven miles west of north of Cahokia. When the group was surveyed March 13, 1900, it was not possible to determine the original shape of several of the mounds. The land had been cultivated for many years and this, with the constant washing and wearing away of the surface, had caused the works to assume an entirely different appearance from their original condition.

The largest mound of this group stood apart and to the west of the main cluster. It was practically destroyed years ago at the time of the construction of two railroads which pass through it, but parts of the work may now be traced between and on either side of the tracks. Many remarkable objects of stone and copper were recovered during the destruction of the structure.

As is shown on the map the large mound stood to the west. The mound nearest it on the east, as determined by the survey of 1900, was 1,200 feet distant and at that time had a maximum elevation of 9.3 feet above the plain, and was of circular form with a diameter of approximately 237 feet. Eastward from this mound are other units of the group. The highest mound of the group at that time measured 10.4 feet, but undoubtedly the large work to the west was originally much higher than any now standing.

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South of the lake, away from the main group, is a single, isolated mound. Others may have stood within the area, all traces of which have disappeared.

CENTRAL OR CAHOKIA GROUP

Surrounding the great Cahokia Mound, which has already been briefly described, were many lesser works, about seventy in number, some of which were more than 40 feet in height. Some were rectangular, others were circular and although at first glance they appear to have been placed without definite order, nevertheless it is quite evident that in several instances they were so arranged as to create inclosed areas, thus conforming with the position of the mounds of the three lesser groups to the north, west, and south of the central cluster.

Unfortunately the large majority of the mounds east and west of the great central structure have been much reduced and modified by the plow, while several have been practically destroyed and a slight rise is all that remains to indicate their position. The inclosure formed of the smaller mounds on the east is clearly defined and gives the impression of having been intentionally planned and arranged, but for what purpose may never be determined. And although many of the lesser mounds have thus lost their original form and appearance, Cahokia remains the most important and impressive native work in the Valley of the Mississippi. As the great mound now stands it should be preserved: to permit its destruction would be a calamity, an irreparable loss to future generations.

The rectangular work immediately southwest of Cahokia was occupied from 1810 until 1813 by a small body of Trappist monks, during which time their garden was on the southern terrace of the great mound. According to the survey of 1875-1876 from which all measurements now given are derived, this lesser mound was 25 feet in height, its base line from north to south was 180 feet and from east to west 200 feet. Just south of this is a small circular work. A short distance east of south of the latter stands a conical mound which rises 44 feet above the plain, having a diameter at base of 150 feet. Immediately east of this is a rather irregular mound 46 feet in height, and possibly other units of this remarkable cluster were even higher and more extensive than these. A rectangular mound southeast of the preceding was, according to the survey mentioned, 40 feet in height, with its base extending 300 feet from north to south and 250 feet from east to west. This reference to several of the lesser works

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FIG. 101.—Airplane photograph showing Cahokia in upper right center. Mounds to the south and southwest are also defined, likewise the country northward. Camera pointed west of north.

FIG. 102.—Airplane photograph showing Cahokia in the upper left corner. The rectangular mound in the center of the picture, just south of Cahokia, rises 46 feet above the original surface. A light snow covers the ground.

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FIG. 103.—Airplane photograph showing mound north of Cahokia, partly removed. Camera pointed west.

FIG. 104.—Airplane photograph showing mound about 1½ miles west of Cahokia. One of the most perfect of the group, and probably quite similar in appearance to the large mound of the St. Louis group which was removed in 1869. Camera pointed northeast.

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will serve to convey an idea of the magnitude of the group as a whole; the most important prehistoric site in the entire valley.

It is of interest to be able to reproduce at this time four aerial pictures of units of the Cahokia group, and these are believed to be the first photographs of American mounds or earthworks to be taken from the air. The negatives, with others, were made during the winter of 1921 and 1922 by Lieut. Harold R. Wells and Lieut. Ashley C. McKinley, stationed at Scott Field, Belleville, Illinois, under instructions of Major Frank M. Kennedy.

Unfortunately, weather conditions during the winter were not favorable for aerial photography, and although many attempts were made ground haze and smoke interfered greatly with the work. As Major Kennedy wrote in part February 6, 1922, after mentioning the mines and factories in the vicinity of the mounds: "These activities produce a large amount of smoke which seems to settle near the ground and form a blanket two or three hundred feet thick." Nevertheless the four pictures are shown to record the first attempt to photograph mounds from an airplane.

On the summit of the bluffs northeast of Cahokia, as indicated on the map, are two mounds of great interest which command a wide view of the lowlands extending to the Mississippi, and beyond. Both are of conical form and rise 30 feet or more above the original surface. One, as it appears from the foot of the bluff, is shown in figure 105.

A view of the bluffs, with the beginning of the lowlands which slope westward to the bank of the Mississippi, is reproduced in figure 106. This is looking northward from a point southeast of Cahokia.

Extending from the main group which surrounded the great mound, in a direction south of west and following a slight ridge, is a chain of works which terminated in an irregular group of smaller mounds near the bank of the Mississippi. It is to be regretted that all units of this group have now disappeared.

WEST OR ST. LOUIS GROUP

There formerly stood on the right, or west bank of the Mississippi, on the summit of the high bluff within the limits of the present city of St. Louis, an interesting group of mounds, twenty-seven or more in number. All have now disappeared but fortunately their positions were indicated on early maps of the city.

One of the earliest as well as most detailed descriptions of the mounds was that prepared by members of the Long Expedition, more than a century ago. At that time they stood north of the settled

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FIG. 105.—Conical mound on summit of the bluff northeast of Cahokia.

FIG. 106.—Looking northward from near the road leading to Belleville, showing the eastern border of the lowlands which extend westward to the Mississippi.

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FIG. 107.—St. Louis from the Illinois bank of the Mississippi, 1840. Showing the large mound in the northern part of the city.

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portion of the town and were in their primitive condition, but soon the settlement was to extend northward and the mounds were destined to be leveled. A view of St. Louis from the east, taken from the Illinois bank of the Mississippi during the year 1840, is reproduced in figure 107. Far to the north of the principal structures of the town, on the extreme right of the picture, stands the large detached mound. The main group was below, probably near the middle of the picture.

The large isolated work was more than 1,400 feet north of the main cluster which formed an inclosure, thus conforming with the arrangement of the mounds on the opposite side of the river. This most important work was of oval form, with the maximum diameter of its base, from north to south, 319 feet, and from east to west 158 feet. The dimensions of the summit plateau were 139 feet and 11 feet. Height 34 feet. On the eastern side, facing the river, was a terrace resembling that on the south side of Cahokia, which was 79 feet from east to west and probably extended the entire length of the structure.

At the time of the destruction of the great mound in the year 1869 a most remarkable cavity was discovered within it. This was a burial chamber which could be traced for a distance of 70 feet and part had previously been removed. It had probably been constructed of logs over which the mass of earth had been deposited and shaped. Within were encountered human remains in the last stages of decay, and associated with these were vast quantities of shell beads and other objects. This was truly a remarkable structure and one which should have been preserved, but unfortunately it shared the fate of the lesser mounds of the group, all traces of which have now disappeared.

SOUTH GROUP

The southern part of the American Bottom—a name long applied to the lowlands occupied by the ancient works mentioned in this sketch—across the Mississippi from Jefferson Barracks, becomes quite narrow, the bluffs approach the river and are, in some places, a scant mile from the low marshy ground which was formerly covered with water the greater part of the year. But the land extending along the foot of the bluffs at this point was evidently at one time occupied by a village of some importance which stood in the midst of a group of mounds. This may be designated the south group and in some respects resembles the north or Mitchell group, already described.

The site was visited by the writer during the latter part of October, 1921, at which time a plan of the group was made, this now being included on the general map. As is indicated there are now seven

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mounds standing on the lowland and one, a large conical structure, on the bluff to the east. It is said that until a few years ago, at the time of the construction of several railroad embankments, five mounds extended in a row southward from the one now remaining nearest the bluffs, consequently these, together with the five now remaining, formed an inclosure quite similar to the north group. Northward from the main cluster or inclosure, are two detached mounds, both large and prominent. The group as a whole and as it originally stood, must have been as interesting and imposing as either the north or

FIG. 108.—Village site and mounds at Bixby, with bluffs beyond.

west groups as already described, and all were probably of equal importance to their builders.

Unfortunately, the majority of the remaining units of the group have been greatly reduced and modified by the plow and consequently it is not possible to determine their original size or form. However, it is evident the second mound from the south, on the west near the Mississippi, was rectangular and quite large. It appears to have been oriented with its sides facing the cardinal points, as were the units of the other groups, including the great mound. At the present time it is worn down by long-continued cultivation and now measures about 12 feet in height, with a diameter of 200 feet. A photograph looking eastward from the summit of this work is reproduced in figure 108.

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This is a view over the plain once occupied by a native village and shows the bluffs in the distance. Fragmentary pottery and objects of stone are now found scattered over the intervening ground.

As has been mentioned, and as is shown on the map, a conical mound stands on the bluff just east of the main group. It is not on the highest point, not on the summit, but on a commanding spot visible from miles away, north and south, and from far westward across the Mississippi. It is on the bluff in the exact middle of figure 108, and a closer view, taken from the south, is shown in figure 109. This resembles the two mounds on the bluffs northeast of Cahokia and is of equal interest.

FIG. 109.—Conical mound on bluff east of Bixby.

No other area of equal size in the entire valley of the Mississippi appears to have been of so great importance to the native tribes as that mentioned in this sketch. Here they reared their greatest monument, Cahokia, and surrounded it with many lesser works. The several distinct clusters should be considered units of a greater group, in which the massive terraced work stood as the central structure. This was the gathering place of a numerous people, but when or whence they came can never be known. Now, two and one-half centuries after the region was first entered by the French, at which time Illinois tribes were occupying small villages near the banks of the Mississippi, the majority of the ancient mounds have disappeared, but Cahokia remains and it should ever stand. It must be saved as have the pyramids of Egypt; a monument of another race whose origin is shrouded in mystery.

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ARCHEOLOGICAL INVESTIGATIONS AT PUEBLO BONITO, NEW MEXICO

Mr. Neil M. Judd, curator of American archeology, U. S. National Museum, began work during the year on a five-year archeological project undertaken by the National Geographic Society, mentioned in the Smithsonian Exploration Pamphlet for 1920,[1] centering about Pueblo Bonito, one of the largest and most important prehistoric ruins in the United States. Mr. Judd left Washington for New Mexico on May 1 and shortly thereafter began operations in the

FIG. 110.—Pueblo Bonito, from the northwest, showing the vast accumulations of fallen wall material and wind-blown sand which cover the ruin. The present height of the north wall is indicated by the three figures in the left center. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

great ruin; his staff consisted of seven assistants with Navaho and Zuñi Indians employed for the actual work of excavation.

The first few weeks were largely devoted to development of a water supply sufficient for the expedition camp, to transporting equipment and provisions from the railroad, 62 miles distant, and to removal of several hundred tons of fallen wall material and wind-blown sand which had accumulated in that section of the ruin selected for the season's explorations. Following these preliminaries attention was

[1] Smithsonian Misc. Coll., Vol. 72, No. 6.

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directed, respectively, to the central and southeastern portions of the pueblo. The central wing was considered of prime importance since it included the Great Kiva, the civil and religious heart of Pueblo Bonito; the southeastern quarter was chosen because its masonry, apparently the most recent of all in the village, suggested that antiquities found in this area would illustrate the very apex of cultural advancement by the ancient Bonitians, thus forming an index for subsequent discoveries.

FIG. 111.—Zuñi workmen pointing out features of the masonry in Pueblo Bonito, which is far superior to that in their own village. The skill exhibited by the ancient artisans was a source of constant admiration to these modern Pueblos. (Photograph by Neil M. Judd. Courtesy of the National Geographic Society.)

Altogether, fifty secular rooms and five kivas were excavated during the summer. In addition, a number of dwellings previously opened were cleared of their individual accumulations of wind-deposited sand and other débris. An outstanding result of this work was identification of three distinct types of masonry, each illustrating the dominant construction method at a given period during occupancy of the village. It is, of course, still too early to designate the factors which brought about these various styles in building, just as any present effort to trace the ground area formerly occupied by each of the three types

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FIG. 112.—Central portion of Pueblo Bonito, from the south, showing the north cliffs of Chaco Canyon towering above the ruin. Some of the rooms were so large that the initial work of excavation could be done directly with teams. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

FIG. 113.—An excavated kiva in Pueblo Bonito, showing the low encircling bench and, above this, the roofing timbers which overlap above the pilasters. At the left will be seen the decayed fragments of upright hewn planks which stood between the dome-shaped roof and the circular wall of the chamber. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

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FIG. 114.—Excavating the Great Kiva. The block of masonry in the middle is the fireplace; that in the lower right, an inter-pillar compartment. The piles of stone at the top consist of blocks retained for repair of the ancient walls. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

FIG. 115.—The Great Kiva and its surrounding rooms, as seen from the cliffs north of Pueblo Bonito. This remarkable structure is 52 feet in diameter; it was the largest and most important ceremonial room in the village. A trench for stratigraphical examination of the west refuse mound will be noted at the upper left center. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

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would be premature. Dwellings were razed and replaced by other structures as Pueblo Bonito grew in size and population.

Those walls which appear to have formed the nucleus of the village are crude and irregular; the rooms they inclose are relatively small and low of ceiling. In contrast to these, walls of the second type exhibit an infinite amount of patience and attention to detail. They consist of rather large uniform blocks of friable sandstone, dressed on the face only, laid in adobe mud and chinked with innumerable small, thin chips. Equally marked in its variation from that in the oldest houses is the masonry of the third type mentioned. In this, uniformly thin tablets of laminate sandstone were utilized with a minimum of adobe and little or no chinking. Larger blocks were frequently laid in bands both for the decorative effect produced and as bonds to hold the masonry veneer to the earthy core of the wall. Beneath the floors of a large number of the rooms excavated during 1921 were found the razed walls of older structures in which a different style of construction prevailed.

These principal variations in masonry may represent merely local developments—the will of ascendant influences in Pueblo Bonito—but it seems more reasonable to believe that each came in upon a wave of immigration from other regions. Among the collections made during the summer are specimens of pottery characteristic of the Mesa Verde cliff-dwellings in Colorado, of the prehistoric ruins in the Kayenta and Gila River districts of Arizona and of the Rio San Francisco, New Mexico. The very number of these objects would indicate not that they had been introduced through intertribal commerce but rather that their makers had come to dwell at Pueblo Bonito, bringing with them their own distinctive arts and industries. On the other hand, it is manifest that the prehistoric Bonitians maintained an active trade with other primitive folk at a great distance from their terraced village in Chaco Canyon. The quantity of Pacific coast shell—used for beads, pendants and other ornaments—copper bells from central Mexico and especially skeletons of the great macaw (*Ara macao*), furnish abundant proof that adventurers from Pueblo Bonito or friendly traders from distant valleys braved the rigors of open desert travel long before the Spanish conquistadores introduced the horse and other beasts of burden.

The circular kivas in Pueblo Bonito, as elsewhere, were both council chambers where clan representatives met for consultation and religious sanctuaries in which secret ceremonies were enacted and preparations made for public rituals to be held in the open courts of the

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FIG. 116.—Repairing third-story walls in Pueblo Bonito. Some of these high walls had been so weakened by vandalism and the elements that their repair was necessary before excavation could safely be undertaken beneath. The work will serve, also, to preserve the present height of the walls for many years to come. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

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FIG. 117.—Repaired walls of the third type of masonry, showing occasional bands of thicker blocks inserted for strength and decorative effect. Corner doorways are not uncommon in Pueblo Bonito; they provided a direct means of communication between neighboring dwellings occupied by members of the same family or clan. (Photograph by Neil M. Judd. Courtesy of the National Geographic Society.)

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FIG. 118.—A Zuñi Indian in an ancient Bonitian doorway. The excellence of the masonry and the trueness of the corners are well illustrated in this picture; a typical lintel of pine poles will be noted at the top. (Photograph by Neil M. Judd. Courtesy of the National Geographic Society.)

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FIG. 119.—A trench 20 feet deep was cut in the west refuse mound in order to obtain chronological data. Potsherds deposited during the early occupancy of Pueblo Bonito were quite different from those found near the surface of the mound. (Photograph by O. C. Havens. Courtesy of the National Geographic Society.)

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village. These important structures were constructed both below the level of the plazas and among the living rooms, in which latter case the surrounding walls were so arranged as to simulate the required subterranean position. In certain features of construction and equipment, however, Bonitian kivas—judging from the five already excavated—differ from those heretofore examined in other sections of

FIG. 120.—Pueblo Bonito as seen from the north wall of Chaco Canyon. The ruin is semicircular in shape and covers more than three acres of ground. Its dwellings were terraced upward from two inner courts; its outer wall was unbroken except for small, elevated ventilators. Excavations thus far have disclosed but one entrance, that from the south. (Photograph by Charles Martin. Courtesy of the National Geographic Society.)

the Southwest. The ventilator shaft is connected with a manhole in the room through a hidden tunnel; sub-floor chambers are sometimes, but not always, present; the primary roof supports or pilasters have been so specialized as to lose their original stability and to take on a new function, that of depositories for ceremonial offerings.

The Great Kiva possesses several noteworthy features not found in the lesser structures of its kind. It is a room of exceptional size,

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being 52 feet (15.85 m.) in diameter with a ceiling formerly 11 feet (3.35 m.) high. The central portion of its flat roof was supported by four masonry pillars each of which had a separate foundation of low grade, soft coal. On the east and west sides of the chamber, between the pillars, were built-in receptacles, probably for containing ceremonial paraphernalia. A fire box with protective screen stood at the

FIG. 121.—A naïve example of Bonitian engineering. In an obvious attempt to hold up a huge section of cliff which threatened to topple upon their village, the ancients placed pine props under the weathered section and covered these with a great terraced mass of masonry. The north wall of Pueblo Bonito stands at the left. (Photograph by Charles Martin. Courtesy of the National Geographic Society.)

south side and, opposite this, a flight of narrow steps led to an elevated room in which a central block of masonry represented the "altar."

Excavation of the kivas and secular rooms in Pueblo Bonito is contributing in large measure to our knowledge of the prehistoric sedentary peoples of the Southwest. Chronological data from the vast accumulations which comprise the adjacent refuse mounds is expected to illustrate not only the character and extent of local cultural development but to serve also as a medium of correlation between the ancient Bonitians and other aboriginal peoples of the south-

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western United States. Through such data it is hoped ultimately to arrive at the approximate age of this famous center of pre-Columbian civilization.

The National Geographic Society proposes, as an essential feature of its Pueblo Bonito Expedition, to conduct dependent researches which will seek to determine the ancient source of water supply; the agricultural possibilities of Chaco Canyon in prehistoric times; the rapidity of subsequent sedimentation; the age and probable source of the large timbers used in roofing the dwellings of Pueblo Bonito, and the geophysical changes, if any, brought about since abandonment of the great ruin. These are lines of investigation which may result in information of far-reaching significance and yet they have been generally neglected, heretofore, in connection with archeological explorations.

ARCHEOLOGICAL FIELD-WORK IN SOUTH DAKOTA AND MISSOURI

In the fall of 1921 Mr. W. E. Myer, a voluntary collaborator of the Bureau of American Ethnology, investigated sites in South Dakota and western Missouri, known to have been occupied by the Omahas and Osages in early historic times, after they had come in contact with the whites but before they had been changed thereby to any considerable extent.

Especial attention was paid to any resemblance to the ancient cultures found in the valleys of the Ohio, Cumberland, and Tennessee rivers. This line of research was suggested by certain traditions of both the Omahas and Osages, as well as some of the other branches of the great Siouan linguistic family, that they had at one time lived east of the Mississippi River, on the Ohio, and elsewhere, and after many wanderings, stopping here and there for years, finally reached their present sites in South Dakota and western Missouri.

THE OMAHA SITES

Mr. Francis La Flesche reported that the traditions of his people, the Omahas, stated that they had occupied two important villages on what the Omahas call "The Big Bend of the Xe," at some time in the seventeenth or eighteenth century. These traditions also told of many important events while the Omahas dwelt on these two sites.

Aided by these traditions, Mr. Myer was enabled to locate these two ancient villages. He found one of these on the Big Sioux River, at its junction with Split Rock River, designated Split Rock site in this report.

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He found the other site where the Rock Island Railroad now crosses the Big Sioux River, about 10 miles southeast of Sioux Falls. It is designated here the Rock Island site.

ROCK ISLAND SITE

Sometime in the seventeenth century the Omaha and Poncas removed from the Pipestone regions in Minnesota and finally, after some further wanderings, built a fortified town on the Big Sioux River at the Rock Island site. While living in this fortified Rock Island site they were attacked and defeated by an enemy, most probably the Dakotas, and finally forced to leave the region. Before leaving, they buried their dead from this fight in a mound on this site. This burial tradition was confirmed by excavations made by Mr. A. G. Risty and Mr. F. W. Pettigrew, who report finding a considerable amount of human bones in one of the mounds. Some glass beads and small copper bells of white man's make were also found in one of the mounds on this site. There is evidence that this site was occupied somewhere between 1700 and 1725.

SPLIT ROCK SITE

After leaving the Rock Island site, the Omahas and Poncas roved without long permanent settlements for several years, but finally returned to their beloved Xe and built a permanent village at Split Rock site on "The Big Bend" at the junction of the Big Sioux and Split Rock rivers.

The month of October, 1921, was spent exploring this Split Rock site. Many interesting relics of the Omahas were here unearthed, which throw new light on the life of these people before they had been very much changed by contact with the whites.

There is a group of 30 mounds on the ridge between the two rivers marking the site of that portion of the old town occupied by the Omahas. On a hill one-half mile to the east was a group of ten more mounds, occupied by the Poncas before they split away from the Omahas at this old town.

On the tall ridge 1½ miles to the west, by following the clues furnished by the traditions, three low mounds were discovered. These were said by the traditions to have been on the site of the lookouts for the main village. These lookout mounds command a view, ranging from 6 to 15 miles, on all sides. The mounds on this Split Rock site appear to have nearly all been used for burial.

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The exploration of mound No. 1 showed that the Indians had selected for its site the summit of a beautiful little knoll on the edge of the steep bluff-like bank of Split Rock River. In the soil of this summit they dug a shallow pit, about 12 feet by 6 feet, and 2 feet deep. In this shallow pit bones belonging to five bodies had been placed. Several of these bodies appeared to have been buried after decay of the flesh. One body appeared to have been buried in the flesh, closely flexed, and this human bundle placed in the pit. The position of the

FIG. 122.—A portion of the layer of human bones on floor of charnel pit.

skeleton of a horse with a crushed frontal bone showed that when this body-bundle had been placed in the pit, a large horse, about seven years of age, had been led to the knoll and there killed, on the edge of the pit, by the side of this body-bundle. Then, over all these, a low, round-topped mound, 60 feet across base and 5½ feet in height, had been raised.

Mound No. 2, the largest mound of the group, was near the center of the village. It was round-topped, 110 feet across base, and 10 feet high. This mound proved to be of considerable importance. In beginning its construction, a rectangular charnel pit, 12 feet by 14 feet, and 2 feet deep, had been dug in the surface of the soil near the center of the town. This empty pit was then thoroughly coated with a white layer, about ⅛ inch in thickness. This white coating was made from calcined bones.

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The bottom and sides of this white pit were then probably covered with soft furs. This is indicated by a thin black layer of animal matter next to the white coating.

On the floor of this fur-lined pit, bones representing about 50 human beings had been laid. These bones had been brought from elsewhere after the decay of flesh. The bones presented the appearance of belonging to bodies which had either been left unburied, as on some battle field, or of belonging to scaffold burials. This solid layer of compressed broken and decayed human bones entirely covered the floor of the charnel pit to a depth of from 2 inches to 6 inches.

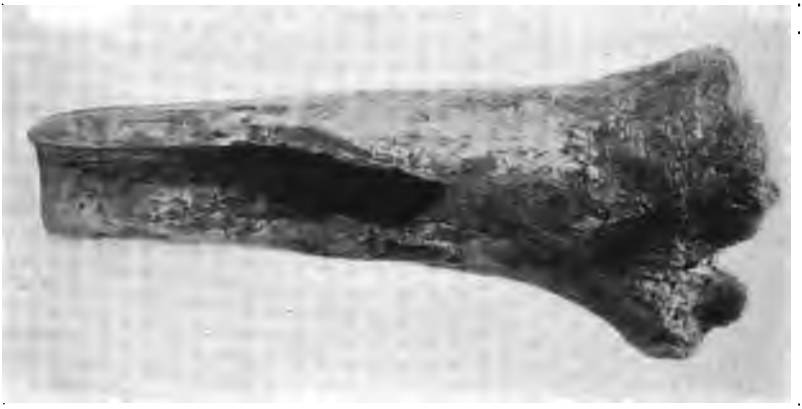

FIG. 123.—Bone flesher.

Portions of this layer of human bones, before it had been disturbed, are shown in figure 122.

On top of this solid mass of human bones traces of the thin fur layer were also found. Over this soft, warm fur covering a layer of bark was laid, and over this bark earth had been spread to a depth of from 3 to 6 inches. This layer of earth was then smoothed and pressed down, and on this surface a white coating, similar to that on the bottom and sides, had been spread. Thus, these human bones, enclosed in their layer of warm furs, were completely incased by this white layer, very much as the filling of a pie is enclosed by the crust. Only one small, cylindrical copper bead was found with all this mass of bones.

On the exterior of this communal charnel pit, on all four sides, the separate burials of several adults and two small children were found. With these outer burials were found several objects. Amongst these was the bone flesher shown in figure 123. With a compact bundle of

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bones belonging to two adults was a small pile of 30 circular ornaments of shell like those shown in figure 124. These ornaments had probably been attached to some garment in the original temporary burial and removed from the decayed garment when placed with the bones in this new burial.

FIG. 124.—Shell ornaments.

No object of white man's manufacture was found on this site. There is evidence that this site was occupied by the Omahas somewhere between 1725 and 1775.

The Omahas and their kindred, the Poncas, lived together at this Split Rock site. It was here that some of the most important events in the history of the Omahas and Poncas took place. While living here the long hostilities between the still united Omahas and Poncas and their old enemies, the Cheyennes and Arikaras, were ended by

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a peace which was concluded with great ceremony at this Omaha-Ponca town. At the urgent request of the Arikara the sacred chant and dance of the calumet was used to cement this great peace pact. In this manner the Omahas and Poncas for the first time came into contact with this the most profoundly binding and sacred ceremony known to savage man.

At this site the age-long association between the kindred Omahas and Poncas was broken. The tradition does not give the cause of their separation; but for some reason the Poncas, after having lived with the Omahas through their long slow wanderings in the regions east of the Mississippi and through the lower and middle reaches of the Missouri Valley, left their kindred and formed a separate tribe.

It was at this site that the Omahas first came to possess the white man's horse, which was to play such an important part in the later Omaha life. The tradition tells that neither the Poncas nor the Omahas had possessed horses until after their separation at this site. The finding of the skeleton of a horse in a mound on this site is one of the many evidences which confirm this tradition that the Omahas remained at this site after the Poncas split away, and shows the Omahas were still living here when they first obtained horses.

OSAGE SITES

In Vernon and Bates counties, western Missouri, near the junction of the Osage and Marmiton rivers, Mr. Myer found several sites known to have been occupied by the Osage Indians in early historic times, shortly after they had come in contact with the whites.

Two of these early historic Osage sites, the village of the Grand Osage and the Little Osage village, were probably located. These were visited by Zebulon Pike in his journey of exploration in 1806.

The site of the village of the Grand Osage was at the junction of the Marmiton and Little Osage rivers, in Vernon County.

The probable site of the Little Osage village of Pike was at the Perry and MacMahan coal mine, about 2 miles northwest of the village of the Grand Osage. Old settlers stated that decayed lodge poles were still standing and many other signs of Indian occupancy were to be seen at this Little Osage site as late as 1840. The present appearance of this site is shown in figure 125.

A considerable collection of surface finds from this site shows no objects of white man's manufacture; but local tradition says fragments of brass kettles, old gun barrels, early bullets, and other objects of white man's manufacture have been found here.

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FIG. 125.—Site of Pike's Little Osage Village.

FIG. 126.—Halley's Bluff.

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FIG. 127.—Site of cache pits at base of Halley's Bluff.

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Two of these surface finds throw light on the extent of aboriginal barter. One of these is a broken obsidian implement. The nearest source of this material is probably in the Rocky Mountains, some 1,000 miles to the west. Another is a shard of Mesa Verde pottery, the nearest source of which is in the Mesa Verde culture region around the southwestern corner of Colorado, about 800 miles to the west.

The largest Osage village in Vernon County is at what is still known as Old Town, on Old Town creek, about 3½ miles south of Pike's village of the Grand Osage. This site covers about 40 acres and is the best known of any of the Osage sites. It has yielded a large amount of iron axes, gun barrels, gun locks, fragments of brass kettles, glass beads, and other articles of early white manufacture. Along with these large quantities of shell beads, flint arrow heads, broken pipes, and other objects of purely aboriginal origin were found. Old Town culture furnishes an excellent example of Indian culture in the days of early contact with the whites.

The most picturesque Indian site in this Osage region is Halley's Bluff on the Osage River, about 1½ miles down stream from where the Marmiton and Marais des Cygnes unite to form the Osage River. A photograph of a portion of this bluff is shown in figure 126. There is evidence showing occupancy of this bluff by Indians long before the coming of the white man and probably before the coming of the Osages.

The long summit of the bluff shows many small, low heaps of stones and other Indian signs. The sheltered spaces at the foot of the overhanging cliffs were out of reach of the highest waters and were sheltered in large degree from the winds and rains. Here, in these dry, sheltered spaces, these ancient people lived and worked. They dug about 20 cache pits at present about 5 feet in depth, in the moderately soft red sandstone.

FIELD-WORK ON THE KIOWA, PUEBLO, AND CALIFORNIA INDIANS

At the end of July Mr. J. P. Harrington, ethnologist, proceeded to California to continue his studies of the Indians of the Chumashan area of that state. Place-names, material culture, and sociology, all these branches being closely related to language, were especially investigated and all obtainable data recorded. By rare good fortune several dozen old ceremonial songs were obtained on the phonograph, with full notes and translation where possible, these songs having not been in use since the middle of the past century. The songs were

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accompanied by the beating of the split-stick, and the rendition, while not what might be desired, will doubtless be adequate for transcription. They belong to several distinct cycles. Interesting comparisons were drawn between the California Indian culture and that of the southwest. The sweathouse is certainly the same as the kiva. The Cali-

FIG. 128.—Aged Mission Indian informant. (Photograph by Harrington.)

fornia phratries correspond to the dual division of the Pueblos. The dancers who represent demons are the Pueblo katcinas. These resemblances also extend to many minor features.

Nor was the linguistic side of the work neglected, ethnology and linguistics, and in fact archeology, of necessity going hand in hand in this difficult field. This linguistic work is of the greatest importance since it furnishes material for comparison with all the related languages.

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Mr. Harrington's field studies reveal the fact that the language of the Kiowa, who are now settled in Oklahoma but formerly had eastern Montana as their habitat, is closely and genetically related to that of the Taos and other Tanoan tribes of New Mexico, which have typical Pueblo culture. Thus, the interesting fact is established that the Taos speak a dialect of Kiowa just as the Hopi, farther west, speak a divergent Shoshonean. These studies also make it clear that Keres and Zuñi are related to each other genetically, and furthermore to Tano-Kiowan and Shoshonean, the languages all having a common origin.

ARCHEOLOGICAL FIELD-WORK ON THE SUSQUEHANNA RIVER, PENNSYLVANIA

In July, 1921, Mr. John L. Baer, Acting Curator of American Archeology of the United States National Museum, examined for

FIG. 129.—Petroglyphs, Bald Friars, Md.

FIG. 130.—Petroglyphs on Miles Island, Susquehanna River, Pa., near Mason-Dixon Line.

the Bureau of American Ethnology a number of instructive pictographs at Bald Friars and Miles Island in the Susquehanna River.

These occur about one-fourth the distance between Bald Friars Station and Conowingo Station, on the Columbia and Port Deposit Railroad.

All the rocks upon which petroglyphs are found seem to have been polished before the petroglyphs were cut in them. The top surfaces of most of the rocks bearing petroglyphs were marked with cups and circular grooves, some of which were concentric. Some of the rocks were fractured destroying the continuity of pictures that originally existed. Upon one large rock broken from its original position possibly by ice are carved two slender fishes headed up-stream. The rock upon which they were found suggests a good stand for shad fishing with a net.

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On a group of low rocks to the northwest of Miles Island is a peculiar arrangement of figures. On one side of a tectiform rock are two concentric circles with radiating spokes, a cup, and two semicircular concentric grooves, while on the ridge and extending down on the opposite side of the roof-like rock is a figure that might represent an animal.

During the same trip, Mr. Baer spent several days on Mount Johnson Island, Susquehanna River, and on the near-by flats below

FIG. 131.—Petroglyphs on Miles Island, Susquehanna River, Pa., near Mason-Dixon Line.

FIG. 132.—Petroglyphs, Bald Friars, Md.

Peach Bottom, Lancaster Co., Pa., seeking further evidences of the bannerstone workshop in which he has been interested for a number of years. He brought back with him a number of broken and unfinished slate bannerstones, flint pecking stones, polishing stones and other utensils showing evidences of a considerable sized workshop on the island. A synoptic series from this workshop showing the different stages in the manufacture of the bannerstone has been placed on exhibit in the Pennsylvania case in the American Archeological collection of the National Museum.

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